Service Manual
Level III

MOTOROLA™

DIGITAL WIRELESS TELEPHONE

TDMA M3090/M3097

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About This Manual

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It is intended primarily to support basic servicing, which consists primarily of mechanical repairs and circuit board replacement.
Authorized distributors may opt to receive additional training to become authorized to perform limited component repairs. Contact your regional Customer Support Manager for details.

Model and Kit Identification

Motorola products are specifically identified by an overall model number on the FCC label. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them.

Service

Motorola regional Cellular Subscriber Support Centers offer some of the best repair capabilities available to Motorola Subscriber equipment users. The Cellular Subscriber Support Centers are able to perform computerized adjustments and repair most defective transceivers and boards. Contact your regional Customer Support Manager for more information about Motorola's repair capabilities and policy for in-warranty and out-of-warranty repairs in your region.

General Safety Information

Portable Operation

DO NOT hold the radio so that the antenna is very close to, or touching, exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if it is held in the same manner as you would hold a telephone handset, with the antenna angled up and over your shoulder. Speak directly into the mouthpiece.
DO NOT operate the telephone in an airplane.
DO NOT allow children to play with any radio equipment containing a transmitter.

Mobile Operation (Vehicle Adaptor)

As with other mobile radio transmitting equipment, users are advised that for satisfactory operation of the equipment and for the safety of personnel, it is recommended that no part of the human body shall be allowed to come within 20 centimeters of the antenna during operation of the equipment.
DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere. Mobile telephones are under certain conditions capable of interfering with blasting operations. When in the vicinity of construction work, look for and observe signs cautioning against mobile radio transmission. If transmission is prohibited, the cellu-

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lar telephone **must be turned off** to prevent any transmission. *In standby mode,* the mobile telephone will automatically transmit to acknowledge a call if it is not turned off.
All equipment must be properly grounded according to installation instructions for safe operation.

Portable/Mobile Telephone Use and Driving

Safety is every driver's business. The portable telephone should only be used in situations in which the driver considers it safe to do so. Use of a cellular portable while driving may be *illegal* in some areas.
Refer to the appropriate section of the product service manual for additional pertinent safety information.

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Specifications

Table 1.Overall System

Function	*Specification*
Frequency Range	**TX (800MHz)** : 824.04 - 848.97 MHz Channels 1 to 799, f_{TX} = 0.03 * N+ 825MHz Channels 990 to 1023, f_{TX} = 0.03(N-1023)+ 825MHz **RX(800 MHz)**: 869.04 – 893.97 MHz Channels 1 to 799, f_{RX} = 0.03 * N+ 870MHz Channels 990 to 1023, f_{RX} = 0.03(N-1023)+ 870MHz **TX (1.9 GHz)** : 1850.01 – 1909.95 MHz Channels 1 to 1999 f_{TX} = 0.03 * N+ 1849.98MHz **RX (1.9 GHz)** : 1930.05 – 1989.99 MHz Channels 1 to 1999 f_{RX} = TX + 80.04MHz
Channel Spacing	30 kHz
Channels	832 (800MHz), 1999 (1.9 GHz)
Duplex Spacing	45 MHz (800MHz), 80.04 MHz (1.9GHz)
Input/Output Impedance	50 ohms (nominal)
Operating Voltage	+4.8 to +5.4Vdc (external connector)
Dimensions	5.1 cubic inches
Weight	3.6 ounces
Display	96 x 32 Graphic Display
Analog RF Power Output	0.398 Watts (26 dBm into 50 Ohms)
Digital RF Power Output	0.562 Watts (27.5 dBm into 50 Ohms)
Automatic Power Control	9, 4 dBm steps

Table 2. EAMPS System

Function	*Specification*
Modulation Type	FM
Frequency Stability	$\pm$ 2.5ppm
Duty Cycle	Continuous
Audio Distortion (transmit and receive)	Less than 5% at 1 kHz; $\pm$ 8 kHz deviation
FM Hum and Noise (C-MSG weighted)	32 dB below $\pm$ 8 kHz deviation @ 1 kHz
Voice Modulation	Maximum $\pm$ 12 kHz deviation
Transmit Audio Sensitivity	9 kHz deviation (nom.) @ 97 dB SPL input @ 1 kHz
Receive Sensitivity	-116 dBm for 12 dB SINAD (C-MSG weighted)
Adjacent and Alternate Channel Desensitization	-16 dB @ +30 kHz, -60 dB @ $\pm$ 60 kHz
IM	Greater than 65 dB

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Table 3. DAMPS System

Function	*Specification*
Modulation Type	π/4DQPSK
Frequency Stability	± 200 Hz
Duty Cycle	32.3%
Error Vector Magnitude (π/4DQPSK mode)	Error Vector Magnitude [Digital] 12.5%
Transmit Audio Sensitivity	TOLR of –46 dB nominal
Receive Sensitivity	-116 dBm for 3% static BER
Adjacent and Alternate Channel Desensitization	-116 dBm for 3% static BER
IM	Less than or equal to 3% static BER
Vocoder	ACELP

Table 4. Environment

Function	*Specification*
Temperature	-30ºC to +60ºC
Humidity	80% RH at 50ºC
Vibration	EIA PN1376
Shock	EIA PN1376

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Cellular Overview

Introduction

A cellular mobile telephone system divides the service area into small, low power radio frequency coverage areas called cells. A cellular system consists of a more or less continuous pattern of these cells, each having a 1 to 40 mile radius (typically 5 - 10 miles). Within each cell is a centralized cell site with an elevated antenna and a building. The building houses a base station with transceivers and related control equipment for the channels assigned to that cell. All the cell sites within a system are then connected either by dedicated land lines, microwave links, or a combination of both to a central control site called the central controller or switch .

The switch controls the entire cellular system and serves as the interface between the cellular telephone user and the landline network. Each cell site operates on an assigned access channel, and may have any number of paging and voice channels assigned to it.

Figure 1. Channel Assignments

A BAND	CHANNELS
Primary Control Channels (21):	313 - 333
Secondary Control Channels (21):	688 - 708
Voice Channels...	001 - 312,
(395 AMPS / 1185 NAMPS):	667 - 716, and 991 - 1023

B BAND	CHANNELS
Primary Control Channels (21):	334 - 354
Secondary Control Channels (21):	737 - 757
Voice Channels...	355 - 666 and
(395 AMPS / 1185 NAMPS):	717 - 799

NOTE:
In NAMPS applications, each AMPS voice channel provides space for three NAMPS voice channels. Digital cellular multiplexes voice channels to allow for the possibility of several additional conversations on a single channel.

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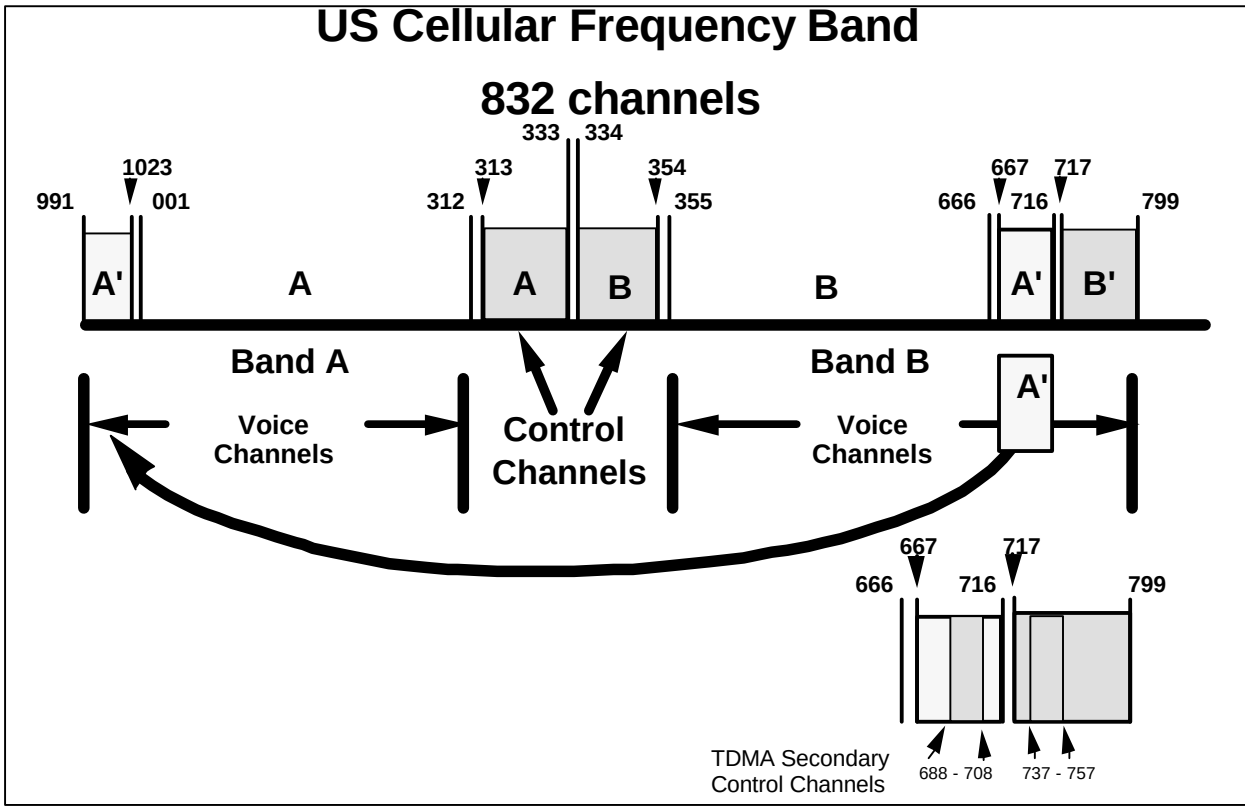
The cellular radio frequency spectrum has been divided by the FCC into two equal segments or bands to allow two independent cellular carriers to coexist and compete in the same geographic coverage area. Each band occupies one half of the available channels in the cellular spectrum. Initially there were 666 channels available across the entire cellular spectrum, but that number was expanded to 832 channels in 1987, and with NAMPS to 2,412 channels in 1991. Digital cellular promises to make a further expansion. To guarantee nationwide compatibility, the signaling channel frequencies have been pre-assigned to each segment (band). The two bands and their assigned channels are defined in Figure 1.

Originally the B Band was assigned to the telephone company (referred to by a euphemism, the Wireline carrier). The A Band, by default, was referred to as the Non-Wireline carrier, guaranteed competition to the telephone company. Today the terms Wireline and Non-Wireline have little meaning since telephone company carriers now operate A Band systems, and vice-versa.

Control (Data) Channels

A cellular telephone in the cellular system is under the indirect control of the switch, or central controller. The central controller uses dedicated control channels to provide the sig-

Figure 2. US Cellular Frequency Band



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naling required to establish a telephone call. Control channels are used to send and receive only digital data between the base station and the cellular telephone. Voice channels are used for both audio and signaling once a call is established. The 21 control channels in each band may be dedicated according to two different applications: access and paging channels.

The data on the forward control channel generally provides some basic information about the particular cellular system, such as the system ID and the range of channels to scan to find the access and paging channels. Access channels are used to respond to a page or originate a call. The system and the cellular telephone will use access channels where two-way data transfer occurs to determine the initial voice channel. Paging channels, if used, are the normal holding place for the idle cellular telephone. When a call is received at the central controller for a cellular telephone, the paging signaling will occur on a paging channel. In many systems both control channel functions will be served by the same control (access) channel for a particular cell. Only in very high density areas will multiple control (paging) channels be required.

Primary control channels are used by all types of telephones. Secondary control channels are only used by TDMA telephones, providing them with an improved probability of locking onto a TDMA control channel.

Voice Channels

Voice channels are primarily used for conversation, with signaling being employed as necessary to handle cell-to-cell hand-offs, output power control of the cellular radiotelephone, and special local control features. Data from the cell site (known as FORWARD DATA) and data from the mobile or portable (known as REVERSE DATA) is sent using frequency shift keying. In AMPS signaling, various control and response tones are used for a variety of applications to be described later. However, in NAMPS signaling, the signaling data and tones have been replaced by sub-audible digital equivalents that constantly ride underneath the audio. And, of course, in digital cellular, all signaling is digital.

Signaling Protocol

In 1983, when the Federal Communications Commission (the FCC) licensed cellular telephony, the signaling protocol used was AMPS. AMPS (Advanced Mobile Phone Service) was the invention of Bell Labs, the signaling protocol that was ultimately adopted by all the governments of the entire Western Hemisphere and, eventually, several other governments throughout the world.

Today, with the implementation of Narrow AMPS and TDMA, and the imminence of CDMA, it may seem that AMPS is out of date. The truth is that AMPS is very much alive, at the very core of all these traffic expanding alternatives to the original signaling protocol developed for conventional cellular telephony.

Under the original AMPS protocol there were 21 control channels assigned to each of two possible carriers in any metropolitan area, with a total of 333 channels assigned to each carrier. Prior to 1987 the FCC had allocated 312 channels to voice (voice, DTMF, or data)

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applications for each carrier. In 1987 the FCC expanded the cellular spectrum (Expanded Spectrum) from a total of 666 channels to 832 channels, allowing for an increase of 83 voice channels for each carrier. But the number of control channels remained constant, *21 control channels for each carrier*.

In 1991, responding to the demand for even more voice channels, Motorola introduced NAMPS (Narrow AMPS), expanding the voice channels by a factor of 3, assuming all subscribers are using NAMPS telephones. But one thing remained constant, there were *21 control channels for each carrier*.

In 1992, when Motorola tested its TDMA digital product, digitizing three communication links on each of 395 voice channels, one thing remained constant: there were still *21 control channels for each carrier*.

Leaving the control channels more or less untouched is the key to allowing telephones that are not capable of NAMPS or digital operation to have access to the system using the conventional AMPS scheme. In virtually every scheme (AMPS, NAMPS, or digital), each control channel has a bandwidth of 30 kHz and uses the signaling protocol, with minor variations for NAMPS and digital, developed for conventional AMPS

The primary difference between NAMPS and AMPS is that a NAMPS voice channel has a bandwidth of only 10 kHz, whereas an AMPS voice channel has a bandwidth of 30 kHz. In addition, NAMPS does not make use of certain control and response tones on voice channels as does AMPS, but uses digital equivalents instead.
As the name implies, the primary difference between digital cellular and AMPS is that all signals are digitized, including voice.

At a basic level, cellular telephony has two divisions: analog cellular and digital cellular. In the following section, analog cellular (AMPS and NAMPS) will be discussed. In the succeeding section, digital cellular will be treated.

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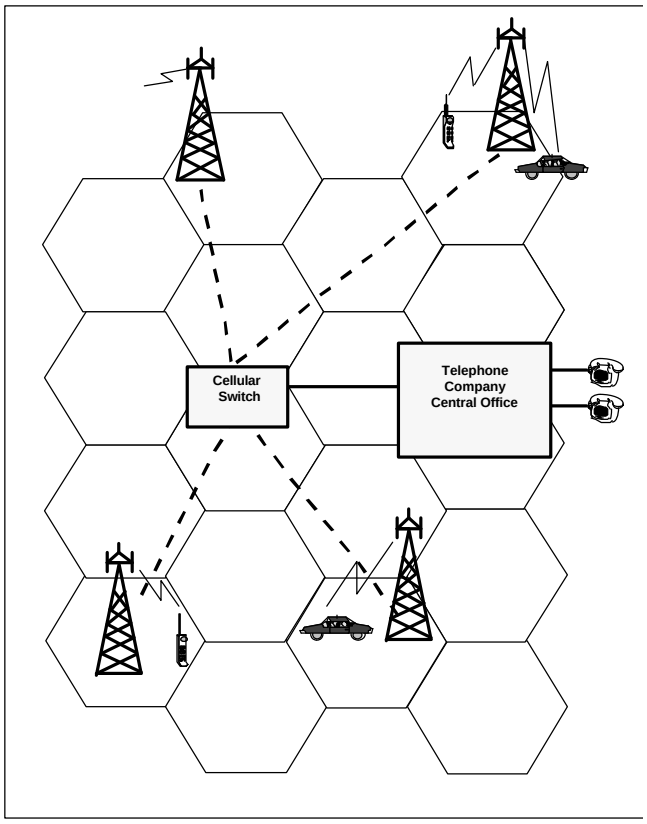
Analog Cellular

The simplified block diagram on page 1 - 7 illustrates an imaginary layout of one side (Band A, or Band B) of a hypothetical service area. The hexagons represent cells, and some of the cell sites shown here also illustrate the fact that an antenna tower and set of base stations are associated with each site. In a real world environment individual cells do not have the hexagonal shape but may take any form as dictated by the environment.

The cell sites are in communication with individual portable and mobile cellular telephones. These portables and mobiles may move from cell to cell, and as they do they are "handed off" under the supervision of the central controller (switch).

Figure 3. Channel Assignments



As illustrated(figure 3.) by the antenna tower on the upper left, cell sites transmit overhead messages more or less continuously even if there are no mobiles or portables active within that cell.

The switch (center left) is in control of the system and interfaces with the central office of the telephone company. As illustrated by the deskset telephones, the telephone company interfaces with the entire landline network.

The cell sites and the mobiles and portables communicate through the use of data or, in the case of AMPS, through the use of data and tones. A complete analysis of data signaling is beyond the scope of this manual. Refer to the Electronic Industries Association standard EIA-553 for a thorough discussion of AMPS signaling protocol, or to Motorola's NAMPS Air Interface Specification for NAMPS.

The tones used in AMPS signaling are Signaling Tones and Supervisory Audio Tones. NAMPS uses sub-audible digital equivalents.

Signaling Tone (ST) and Digital ST (DST)

In AMPS, signaling tone is a 10 kHz signal used by the mobile or portable on the reverse voice channel (REVC) to signal certain activities or acknowledge various commands from the cell site, including hand-offs, alert orders, and call terminations, and to indicate switch-hook operation. Various burst lengths are used for different ST activities. On NAMPS channels ST is replaced by a digital equivalent called Digital ST (DST) which is

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the complement of the assigned DSAT.

SAT (Supervisory Audio Tone) and DSAT (Digital SAT)

The Supervisory Audio Tone (SAT) is one of three frequencies around 6 kHz used in AMPS signaling. On NAMPS channels SAT is replaced by one of seven sub-audible digital equivalents or vectors called DSAT. SAT (or DSAT) is generated by the cell site, checked for frequency or accuracy by the cellular telephone, then transponded (that is, not merely reflected but generated and returned) to the cell site on the reverse voice channel (REVC). The cellular telephone uses (D)SAT to verify that it is tuned to the correct channel after a new voice channel assignment. When the central controller (switch) signals the mobile regarding the new voice channel, it also informs the mobile of the SAT frequency or DSAT vector to expect on the new channel. The returned (D)SAT is used at the cell site to verify the presence of the telephone's signal on the designated channel.

In general there are three uses of (D)SAT: (a) it provides a form of squelch; (b) it provides for call continuation (but if equipped for it, the switch will allow for VOX on all models); and (c) (D)SAT is used to prevent co-channel interference.

DTMF (Dual Tone Multi-Frequency)

DTMF (Dual Tone Multi-Frequency) touch-code dialing may also occur on voice channels. DTMF selects two tones from a total of nine (cellular only uses seven of these tones / four low and three high tones) to uniquely represent individual keys.

Figure 4. Channel Assignments

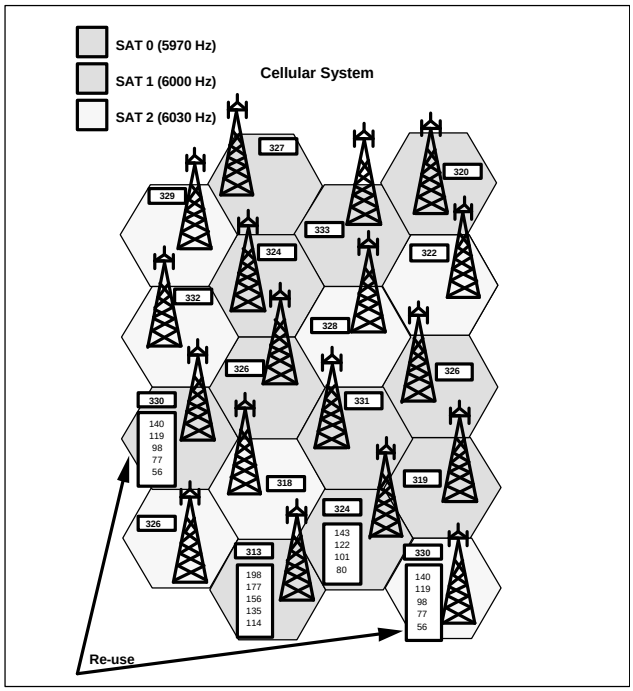

Table 6. DTMF Values

Key	Low Tone	High Tone
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
*	941	1209
0	941	1336
#	941	1477

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Analog Cellular Signal Summary (AMPS and NAMPS)

The diagrams on the following pages outline the various uses of the signals employed in cellular systems. These signals include: SAT (Supervisory Audio Tone) 5970 Hz, 6000 Hz, or 6030 Hz. Used in AMPS for channel reuse, muting audio (squelch), and call continuation [typically ± 2 kHz deviation]. Digital SAT (DSAT) - One of seven codes or vectors used in NAMPS for the same purpose as SAT [± 700 Hz sub-audible NRZ data].

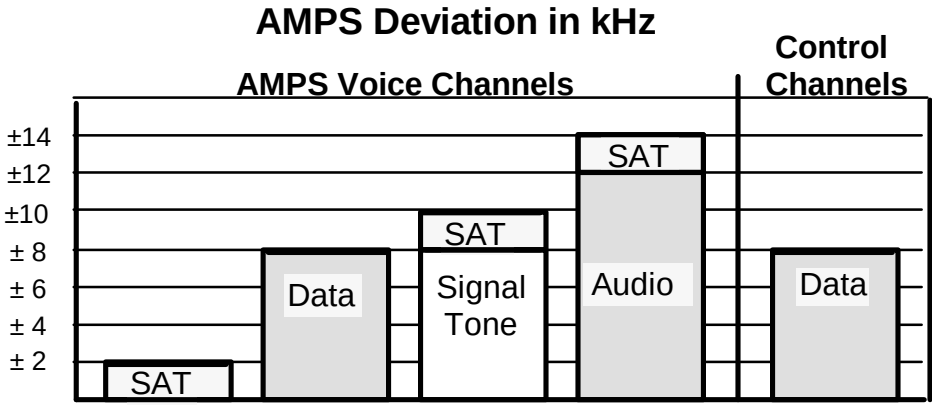
Data - Transmitted at 10 kilobits/second in AMPS and 200 bits/second in NAMPS. Data is used for sending System Orders and Mobile Identification. Do not confuse data with the 10 kHz signaling tone. In AMPS, data is transmitted as Manchester-encoded Frequency Shift Keying (FSK), where the carrier is shifted high or low 8 kHz, and the trailing edge transition is used to represent the logic. In NAMPS, data is transmitted as NRZ (Non-Return to Zero) FSK, where the carrier is shifted high or low 700 Hz, and the frequency shift itself is used to represent the logic.

Signaling Tone (ST) - A 10 kHz tone used in AMPS for mobile ringing, call terminations, hand-offs, and switch-hook operation [typically ± 8 kHz deviation]. ST is always accompanied by SAT.

Digital ST (DST) - One of seven digital equivalents of ST used on NAMPS channels. The transmitted DST is always the complement of the assigned DSAT [± 700 Hz sub-audible NRZ data].

Audio - Includes microphone audio and DTMF [maximum ± 12 kHz deviation AMPS, ± 5 kHz deviation NAMPS]. DTMF deviation should be measured on the radians scale; use key five looking for 9 radians. Audio is accompanied by SAT in AMPS signaling.

Figure 5. AMPS Deviation in kHz



Total deviation of two or more signals is cumulative.

Going into Service

When first turned on, the cellular telephone will scan through the nationwide set of forward control channels (FOCC's) and measure the signal strength on each one. It will then tune to the strongest one and attempt to decode the overhead control message. From the overhead message, the telephone will be able to determine whether or not it is in its home system, and the range of channels to scan for paging and access. Telephones not in their home system will be able to use other cellular telephone systems depending on the level of service requested by the user. If paging channels are used, the telephone next scans each paging channel in the specified range and tunes to the strongest one. On that channel the telephone continuously receives the overhead message information plus paging messages. At this point the telephone idles, continuously updating the overhead message information in its memory and monitoring the paging messages for its telephone number.

Step 1. The telephone powers up and runs a self-test. The NoSvc indicator is illuminated.

Step 2. The telephone scans its preferred system (A or B) as selected in programming.

Step 3. The telephone scans all twenty-one control channels.

Step 4. The telephone tunes to the strongest control channel.

Step 5. Decision point. Can the overhead message from the strongest control channel be decoded? If not, go to step 6. If it can be decoded go to step 8.*

Step 6. The telephone tunes to the second strongest channel.

Step 7. Decision point. Can the overhead message stream be decoded? If not, go to step 12. If it can be decoded, go to step 8.*

Step 8. Decision point. Does the decoded System ID match the Home System ID programmed in the telephone? If not, go to step 9. If it does match, go to step 10.

Step 9. The telephone turns on the ROAM indicator.

Step 10. The telephone turns off the NoSvc indicator.

Step 11. The telephone idles. Typically a rescan occurs after 5 minutes.

Step 12. The telephone turns on (or leaves on) its NoSvc indicator.

Step 13. The telephone switches to the non-preferred system as recorded in programming, and goes back to step 3. The ability to return to step 3 can be disabled by some settings of System Registration.

*The area between Decision point 5 and Decision point 8 can be quite active.
In a few larger systems, following the suc-

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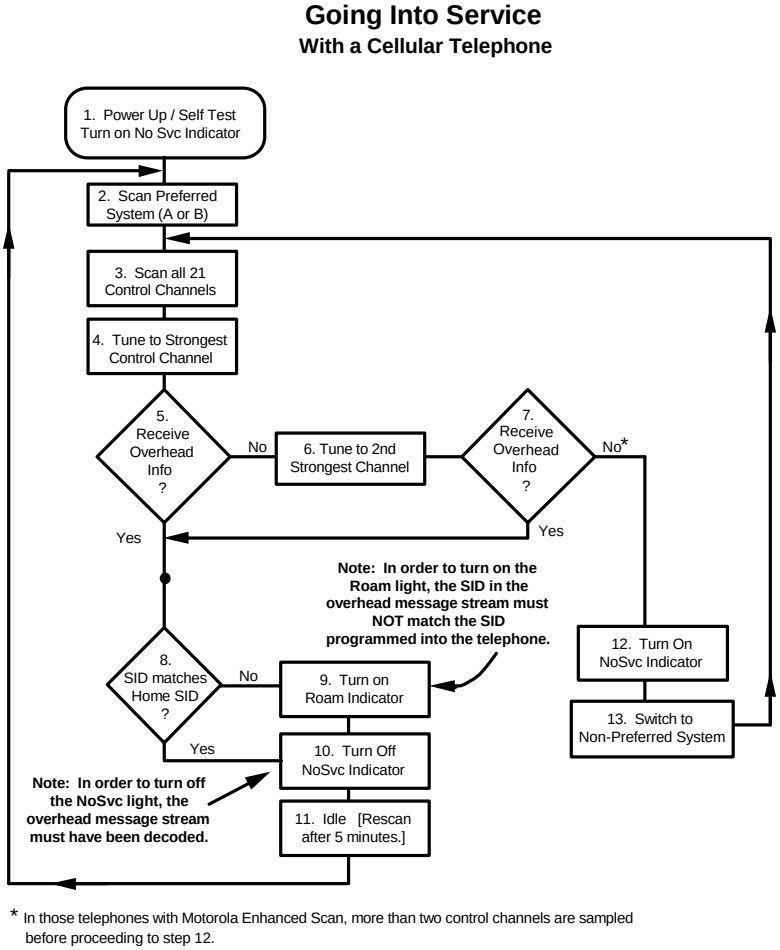
cessful completion of either steps 5 or 7, the telephone scans a set of paging channels, tunes to the strongest, and attempts to decode the overhead message train. The procedure is exactly equivalent to that followed for the access (control) channel. Also at this point, in a few larger systems, the telephone is commanded to identity itself (transmit) and thereby indicate its location in the system. This is called Autonomous System Registration and, like paging channels, is used to improve paging efficiency.

If the system employs Narrow AMPS, part of the overhead message stream is used to ask the for activity on one of the secondary or "digital" control channels, whereas a CDMA telephone will look for pilot signals. If digital signaling is not present, and if the telephone is capable of dual mode operation, it will default to AMPS mode.

Figure 6. Going into Serivce

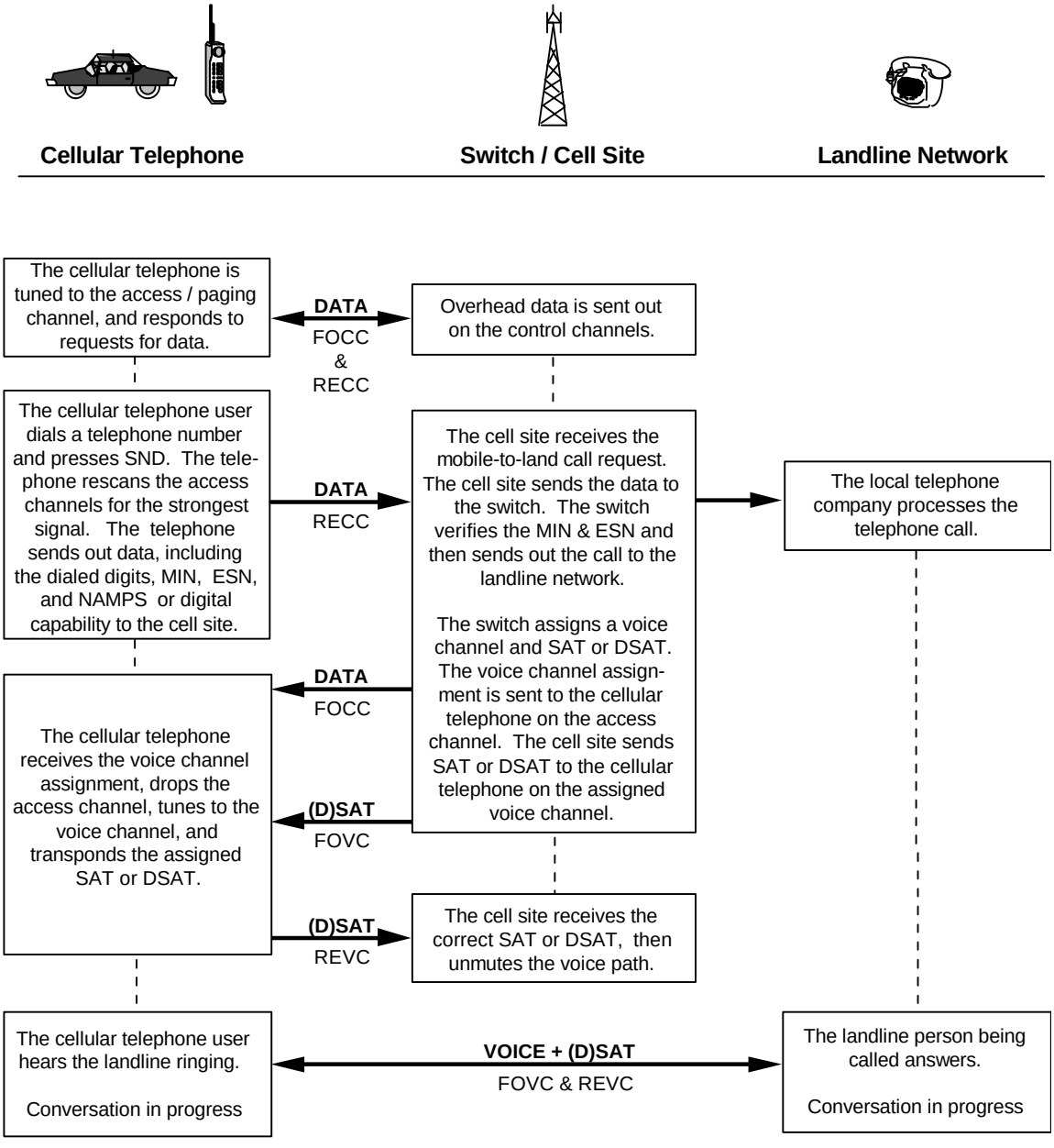

Going Into Service
With a Cellular Telephone
1. Power Up / Self Test
Turn on No Svc Indicator
2. Scan Preferred System (A or B)
3. Scan all 21 Control Channels
4. Tune to Strongest Control Channel
5. Receive Overhead Info ?
No
6. Tune to 2nd Strongest Channel
7. Receive Overhead Info ?
No*
Yes
Yes
Note: In order to turn on the Roam light, the SID in the overhead message stream must NOT match the SID programmed into the telephone.
8. SID matches Home SID ?
No
9. Turn on Roam Indicator
Yes
10. Turn Off NoSvc Indicator
11. Idle [Rescan after 5 minutes.]
12. Turn On NoSvc Indicator
13. Switch to Non-Preferred System
Note: In order to turn off the NoSvc light, the overhead message stream must have been decoded.

* In those telephones with Motorola Enhanced Scan, more than two control channels are sampled before proceeding to step 12.

Placing a Call (Mobile to Land or Mobile to Mobile)

When the cellular telephone user originates the call, the cellular telephone re-scans the access channels to assure that it is still tuned to the strongest one. The cellular telephone then transmits data at the rate of 10 kilobits per second on the control channel to notify the switch of its mobile identification number (MIN) and the number it wants to reach. The switch verifies the incoming data and assigns a voice channel and a SAT (or DSAT for NAMPS channels) to the telephone.

Figure 7. Cellular Telephone to Land Call Processing


Cellular Telephone
Switch / Cell Site
Landline Network
The cellular telephone is tuned to the access / paging channel, and responds to requests for data.
DATA
FOCC & RECC
Overhead data is sent out on the control channels.
The cellular telephone user dials a telephone number and presses SND. The telephone rescans the access channels for the strongest signal. The telephone sends out data, including the dialed digits, MIN, ESN, and NAMPS or digital capability to the cell site.
DATA
RECC
The cell site receives the mobile-to-land call request. The cell site sends the data to the switch. The switch verifies the MIN & ESN and then sends out the call to the landline network.
The switch assigns a voice channel and SAT or DSAT. The voice channel assignment is sent to the cellular telephone on the access channel. The cell site sends SAT or DSAT to the cellular telephone on the assigned voice channel.
The local telephone company processes the telephone call.
DATA
FOCC
The cellular telephone receives the voice channel assignment, drops the access channel, tunes to the voice channel, and transponds the assigned SAT or DSAT.
(D)SAT
FOVC
(D)SAT
REVC
The cell site receives the correct SAT or DSAT, then unmutes the voice path.
The cellular telephone user hears the landline ringing.
Conversation in progress
VOICE + (D)SAT
FOVC & REVC
The landline person being called answers.
Conversation in progress

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The cellular telephone tunes to the assigned voice channel and verifies the presence of the proper forward SAT frequency (or DSAT message). If SAT (DSAT) is correct the telephone transponds SAT (DSAT) back to the cell site and unmutes the forward audio. The cell site detects reverse SAT (DSAT) from the cellular telephone and unmutes reverse audio. At this point both forward and reverse audio paths are unmuted and the cellular telephone user can hear the other end ring, after which conversation can take place. SAT (DSAT) is sent and received more or less continuously by both the base station and the cellular telephone. However, SAT (DSAT) is not sent during data transmissions, and the cellular telephone does not transpond SAT continuously during VOX operation. Also, DSAT is suspended during the transmission of DST. Notice that SAT and Signaling Tones are only used on AMPS voice channels, and that the Signaling Tone is only transmitted by the cellular telephone.

Receiving a Call (Land to Mobile)

Once a cellular telephone has gone into service, it periodically scans the overhead message information in its memory and monitors the paging messages for its telephone number. When a page match occurs the cellular telephone scans each of the access channels and tunes to the strongest one. The cellular telephone then acknowledges the page on that access channel and thus notifies the central controller of its cell location. The switch then assigns a voice channel and a SAT (DSAT) to the cellular telephone. The cellular telephone tunes to the voice channel, verifies the presence of the proper SAT frequency (DSAT message) and transponds the signal back to the cell site. At the cell site, the reception of SAT (DSAT) signals the central controller that the cellular telephone is ready for the call. An alert order is then sent to the cellular telephone which responds with a 10 KHz signaling tone (DST message). The subscriber unit rings for 65 seconds or until the user answers. Then the 10 KHz signaling tone (DST message) is terminated to alert the central controller that the user has answered. The switch then connects the incoming call to the appropriate circuit leading to the cell in contact with the cellular telephone. At this point both forward and reverse audio paths are unmuted and the conversation can take place. SAT (DSAT) is sent more or less continuously by the base station and transponded by the cellular telephone, except during data transmission. DSAT is suspended during DST transmission, and during VOX operation SAT (DSAT) is not transponded continuously by the cellular telephone.

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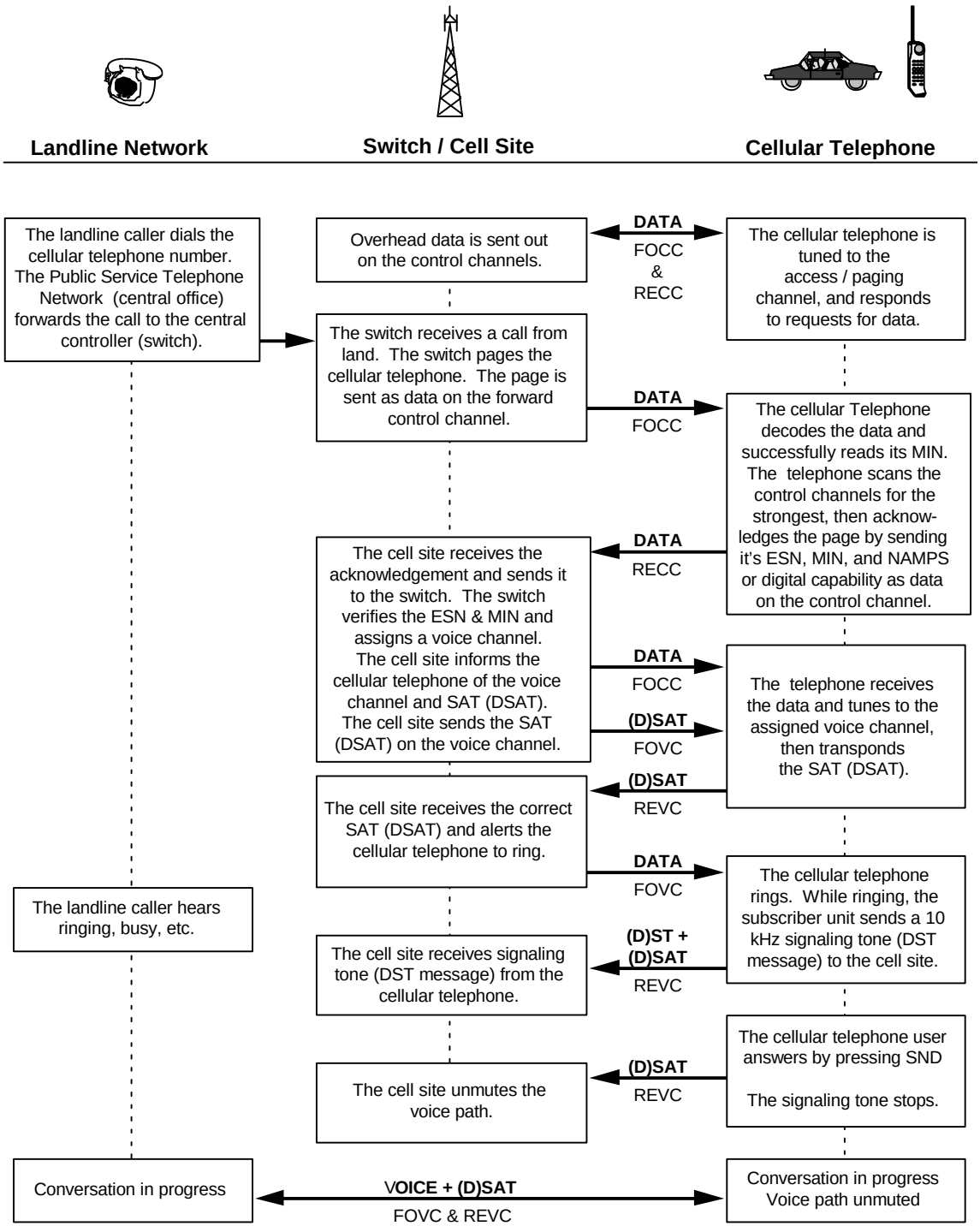
Figure 8. Land to Cellular Telephone Call Processing


Landline Network
Switch / Cell Site
Cellular Telephone
The landline caller dials the cellular telephone number. The Public Service Telephone Network (central office) forwards the call to the central controller (switch).
Overhead data is sent out on the control channels.
DATA
FOCC & RECC
The cellular telephone is tuned to the access / paging channel, and responds to requests for data.
The switch receives a call from land. The switch pages the cellular telephone. The page is sent as data on the forward control channel.
DATA
FOCC
The cellular Telephone decodes the data and successfully reads its MIN. The telephone scans the control channels for the strongest, then acknowledges the page by sending it's ESN, MIN, and NAMPS or digital capability as data on the control channel.
DATA
RECC
The cell site receives the acknowledgement and sends it to the switch. The switch verifies the ESN & MIN and assigns a voice channel. The cell site informs the cellular telephone of the voice channel and SAT (DSAT). The cell site sends the SAT (DSAT) on the voice channel.
DATA
FOCC
(D)SAT
FOVC
The telephone receives the data and tunes to the assigned voice channel, then transponds the SAT (DSAT).
(D)SAT
REVC
The cell site receives the correct SAT (DSAT) and alerts the cellular telephone to ring.
DATA
FOVC
The cellular telephone rings. While ringing, the subscriber unit sends a 10 kHz signaling tone (DST message) to the cell site.
The landline caller hears ringing, busy, etc.
(D)ST +
(D)SAT
REVC
The cell site receives signaling tone (DST message) from the cellular telephone.
The cellular telephone user answers by pressing SND
The signaling tone stops.
(D)SAT
REVC
The cell site unmutes the voice path.
Conversation in progress
VOICE + (D)SAT
FOVC & REVC
Conversation in progress
Voice path unmuted

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Power Steps

As a call progresses, the cell site continuously monitors the reverse channel for signal strength.

Every cellular telephone has a number of power steps ranging from full power (3 watts in a mobile and .6 watts in a portable) down to as low as about half a milliwatt. In reality all cellular telephones have eight power steps, but portable models are prevented from using the two highest power steps by the cell site. Transmit power level commands are sent to the cellular telephone as required to maintain the received signal strength within prescribed limits.

This is done to minimize interference possibilities within the frequency re-use scheme. If the signal received from the cellular telephone is higher than the prescribed limit (such as when the unit is very near the cell site), the subscriber unit will be instructed to step down to a lower level.

Hand-offs

If the cellular telephone is at its maximum allowed power for the cell site it is using and the received signal at the cell site is approaching the minimum allowable (typically -100 dBm), the cell site will signal the switch to consider the subscriber unit for a hand-off. The central controller (switch) will in turn have a scanning receiver at each of the surrounding cell sites measure the cellular telephone's signal strength. The site with the strongest signal will be the site to which the call will be handed to if there are available voice channels.

On an AMPS channel the hand-off is executed by interrupting the conversation with a burst of data (called blank and burst) containing the new voice channel assignment. The telephone acknowledges the order by a 50 millisecond burst of 10 kHz signaling tone on the originally assigned voice channel. The mobile telephone then drops the original voice channel and tunes to the newly assigned voice channel, keying up on that channel and transponding the assigned SAT. But on a NAMPS channel the hand-off is executed with a low speed data transmission that does not interrupt the voice. The telephone acknowledges the order in this case by a DST message. In either case, once the hand-off has been accomplished, the newly assigned cell site then alerts the switch that the hand-off has been completed, and the old voice channel is dropped.

It should be noted that this data exchange happens very quickly, lasting only as long as 260 milliseconds. However, when data or signaling tones are transmitted, audio is muted for the duration of that transmission and a syllable or two may be dropped from conversation. This is normally not a problem, but during data signaling, such as that employed for telefacsimile, answering machine, and computer communications, significant amounts of information may be lost. For this reason it is recommended that when THE Cellular Connection™ equipment is used the vehicle should be stationary to avoid data loss during hand-offs and other data transmissions. Otherwise the equipment should employ an error correction protocol.

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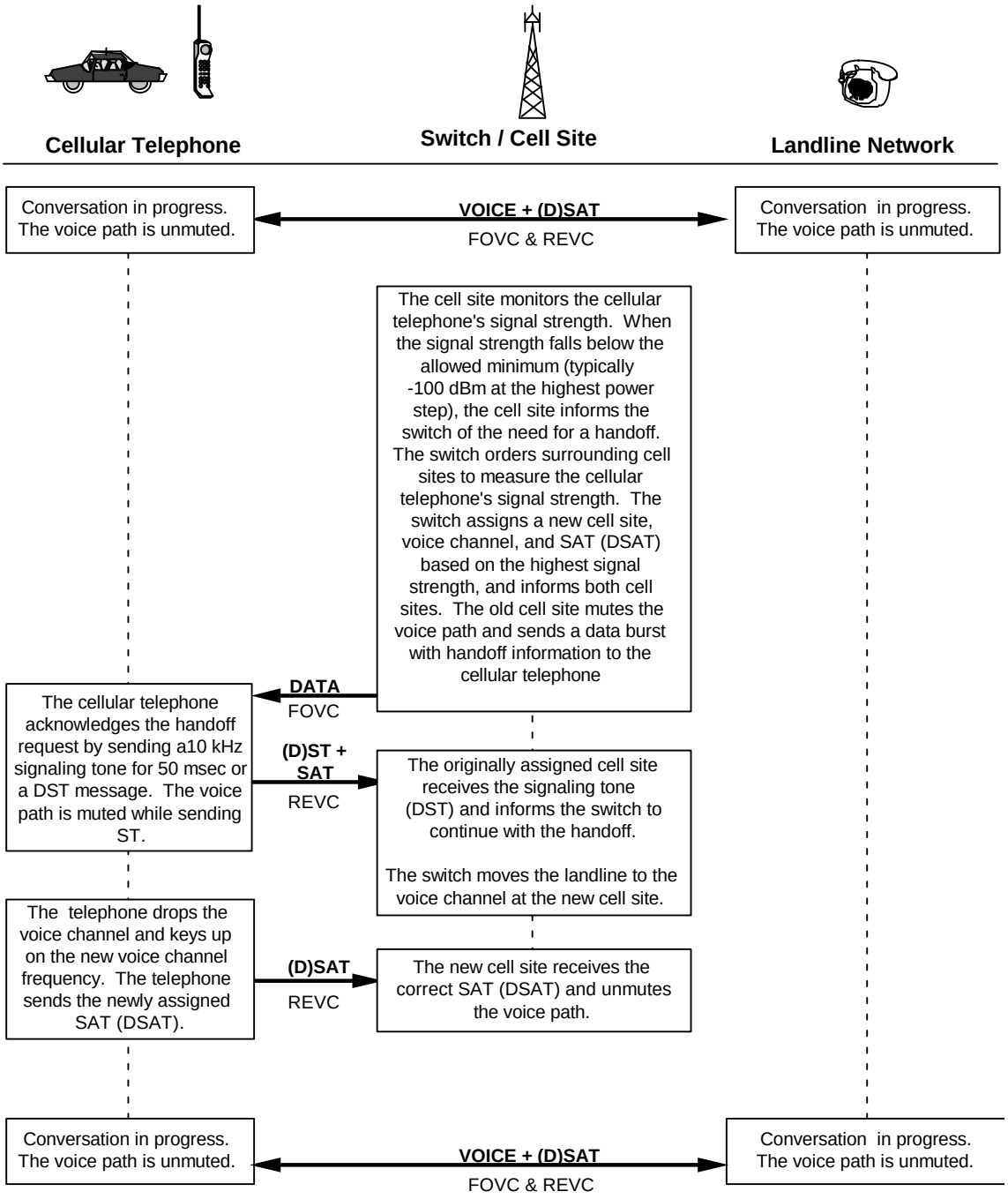
Figure 9. Cell Site Handoffs


Cellular Telephone
Switch / Cell Site
Landline Network
Conversation in progress. The voice path is unmuted.
VOICE + (D)SAT
FOVC & REVC
Conversation in progress. The voice path is unmuted.
The cell site monitors the cellular telephone's signal strength. When the signal strength falls below the allowed minimum (typically -100 dBm at the highest power step), the cell site informs the switch of the need for a handoff. The switch orders surrounding cell sites to measure the cellular telephone's signal strength. The switch assigns a new cell site, voice channel, and SAT (DSAT) based on the highest signal strength, and informs both cell sites. The old cell site mutes the voice path and sends a data burst with handoff information to the cellular telephone
DATA
FOVC
The cellular telephone acknowledges the handoff request by sending a10 kHz signaling tone for 50 msec or a DST message. The voice path is muted while sending ST.
(D)ST + SAT
REVC
The originally assigned cell site receives the signaling tone (DST) and informs the switch to continue with the handoff.
The switch moves the landline to the voice channel at the new cell site.
The telephone drops the voice channel and keys up on the new voice channel frequency. The telephone sends the newly assigned SAT (DSAT).
(D)SAT
REVC
The new cell site receives the correct SAT (DSAT) and unmutes the voice path.
Conversation in progress. The voice path is unmuted.
VOICE + (D)SAT
FOVC & REVC
Conversation in progress. The voice path is unmuted.

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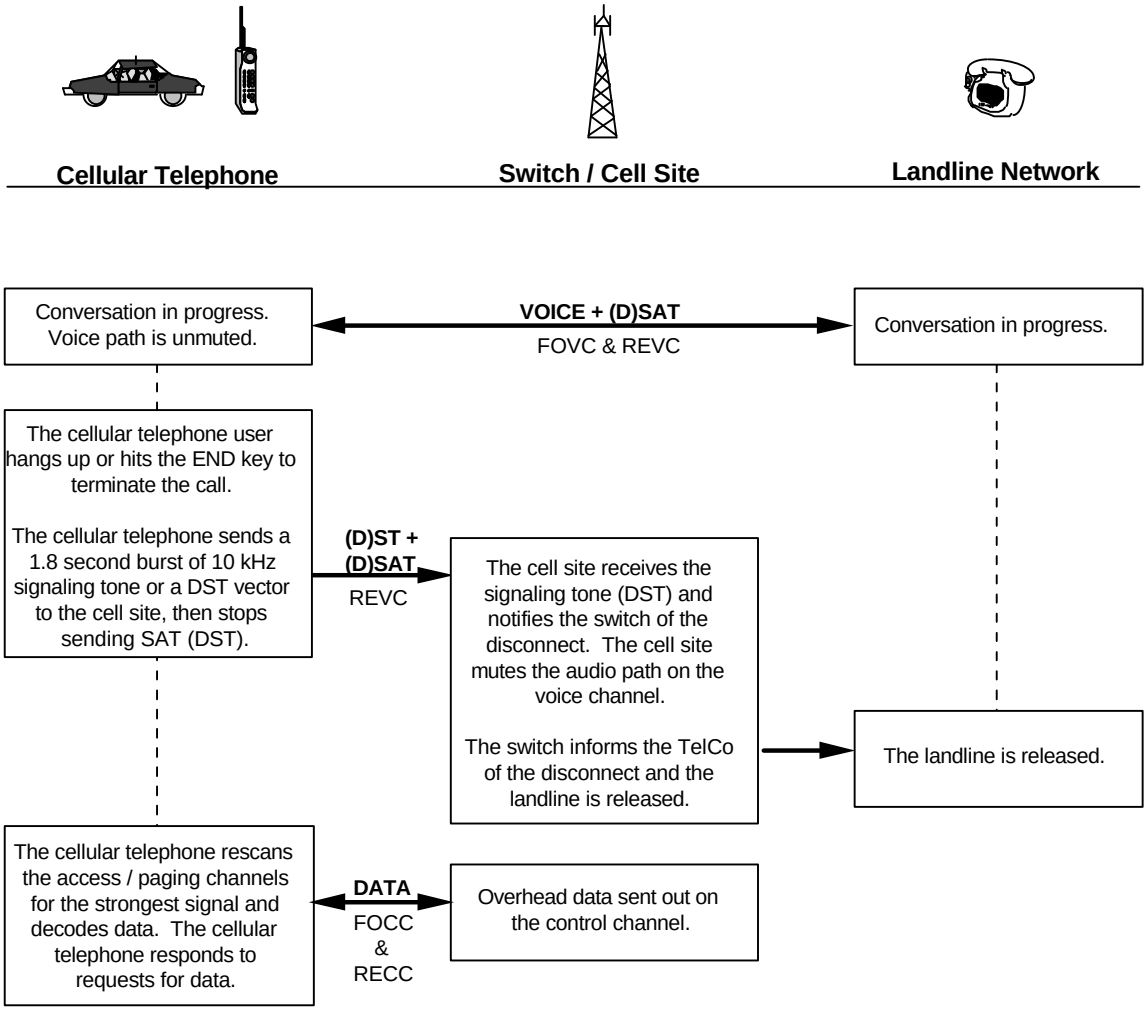
Call Termination

When the call is terminated by the landline caller (not the cellular telephone user), the central controller (switch) issues a release order to the subscriber unit. The cellular telephone acknowledges with a 10kHz signalling tone burst for 1.8 seconds and the cellular telephone ceases transmission.

If the call was terminated by the cellular telephone user, the telephone generates a 10kHz signalling tone burst for 1.8 seconds, indicating a call termination request to the switch. In either case after call termination, the cellular telephone goes back to rescan the nationwide set of forward controlchannels and repeats the Going into Service process it performed at first turn-on to re-establish itself on a paging channel.

Figure 10. Cellular Telephone Call Processing Termination


Cellular Telephone
Switch / Cell Site
Landline Network
Conversation in progress. Voice path is unmuted.
VOICE + (D)SAT
FOVC & REVC
Conversation in progress.
The cellular telephone user hangs up or hits the END key to terminate the call.
The cellular telephone sends a 1.8 second burst of 10 kHz signaling tone or a DST vector to the cell site, then stops sending SAT (DST).
(D)ST + (D)SAT
REVC
The cell site receives the signaling tone (DST) and notifies the switch of the disconnect. The cell site mutes the audio path on the voice channel.
The switch informs the TelCo of the disconnect and the landline is released.
The landline is released.
The cellular telephone rescans the access / paging channels for the strongest signal and decodes data. The cellular telephone responds to requests for data.
DATA
FOCC & RECC
Overhead data sent out on the control channel.

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Digital Cellular

Multiplexing

Using a single frequency to carry two or more communication links (e.g., conversations) is called multiplexing. There are two types of multiplexing that are feasible for cellular: code division multiplexing and time division multiplexing. Both code division multiplexing and time division multiplexing digitize voice before transmitting the signal. Another type of multiplexing, frequency division multiplexing, was briefly considered, then abandoned. We will deal with each type of multiplexing separately.

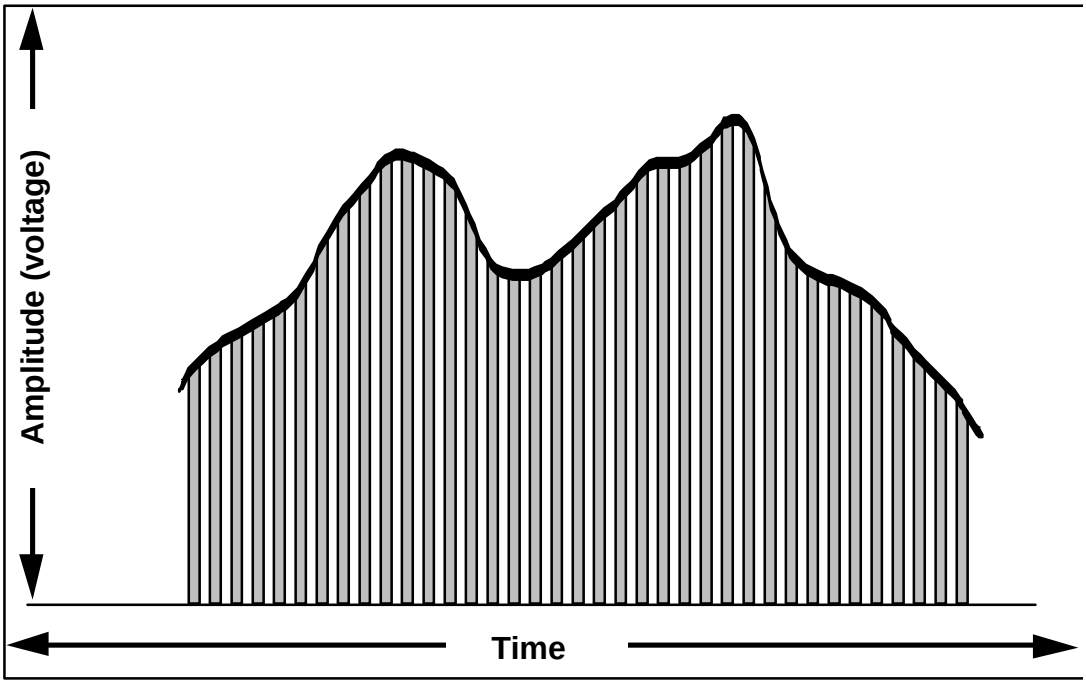
FDMA (Frequency Division Multiple Access)

Frequency Division Multiple Access (FDMA) uses two or more modulated subcarriers to modulate a third true carrier simultaneously. While as many as six communication links can be accommodated on a single frequency with FDMA, the bandwidth requirements are enormous. Given the relatively small 30 kHz bandwidth of cellular, FDMA was never a contender for improving the load carrying capacity of cellular systems. Also, it should be pointed out that FDMA is not necessarily digital.

Digitizing Voice

If a person speaks into a microphone, a transducer in the microphone converts the mechanical air movements produced by the person's vocal cords into varying voltages. If an oscilloscope probe is connected to the output from a microphone, a varying voltage

Figure 11. Digitizing Voice



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line, such as that shown in the accompanying illustration, will be produced.

If the varying voltages are sampled at some rate, the instantaneous voltages can be quantified. Let's say we want to quantify measurements from values of zero to 255 (the maximum value a binary byte can hold). The value of 255 would represent the highest possible voltage we could expect from voice, and zero would represent silence. Each discrete integer between zero and 255 would represent a particular voltage, typically presented in binary form.Because of the redundancies of speech and the inability of the human ear to detect more than a fraction of the intelligence in speech, it is possible to sample a small portion of the sound produced by a person speaking, reproduce that sound at either a later time or another place, then filter the resulting reproduction to produce a "sound" that is indistinguishable from the original source.

In the illustration on page 1 - 19 we saw how speech could be sampled at some rate. Suppose we take only one of every three samples. If our sampling rate is fast enough, and if we can compress the samples, it turns out that we can interleave several different conversations (communication links) on a single frequency. However, we also have to provide some mechanism for ensuring that the transmitter and receiver are in synchronization, and we have to provide for some alternative to the control and response tones used in conventional AMPS. All of these non-voice signals are digital and take time from the assigned time slot, leaving only a relatively small amount of time to represent voice. For this reason the digital receiver has to filter the audio to closely approximate the original audio.

TDMA (Time Division Multiple Access)

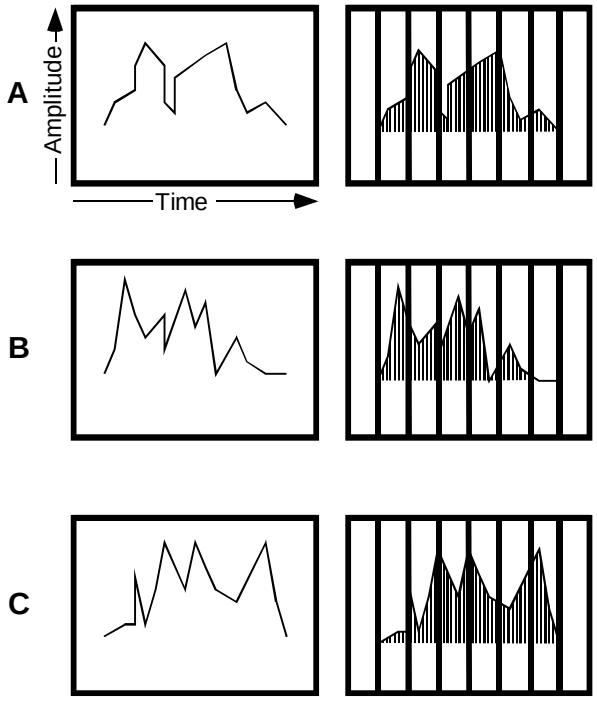
Time Division Multiple Access (TDMA) today provides a times-3 increase in the number of communication links a channel can carry (just like NAMPS). Eventually TDMA is expected to take full advantage of all six time slots, allowing for six communications links in the bandwidth of a conventional AMPS channel.

TDMA, like CDMA, employs a form of phase shift keying to represent symbols. However, TDMA also compresses the digitized signal, making use of predictive algorithms to reduce the number of symbols actually transmitted.

Digitization and TDMA

Here three conversations, represented by

Figure 12. Digitization and TDMA



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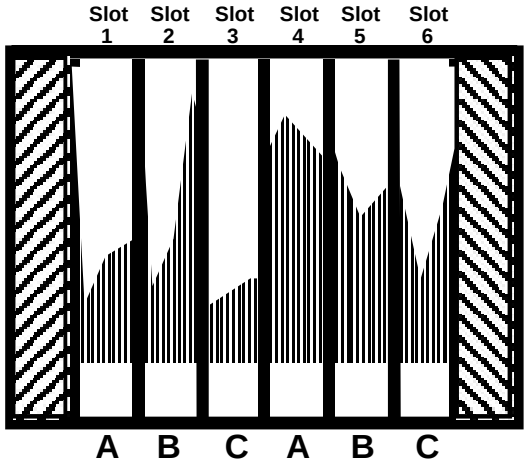
voice samples as viewed on oscilloscopes, are clearly shown to be nothing more than varying voltages produced by microphones. Instantaneous samples are discrete voltages. It has been shown that if the sampling rate is fast enough, it is possible to make a faithful representation of each conversation.

If these samples are then compressed, it is possible for more than a single conversation to occur on a single medium (such as a radio frequency) by sharing time slots. Here we see three conversations being shared on six time slots. The conversations shown are compressed sampled analog audio, not yet digitized.

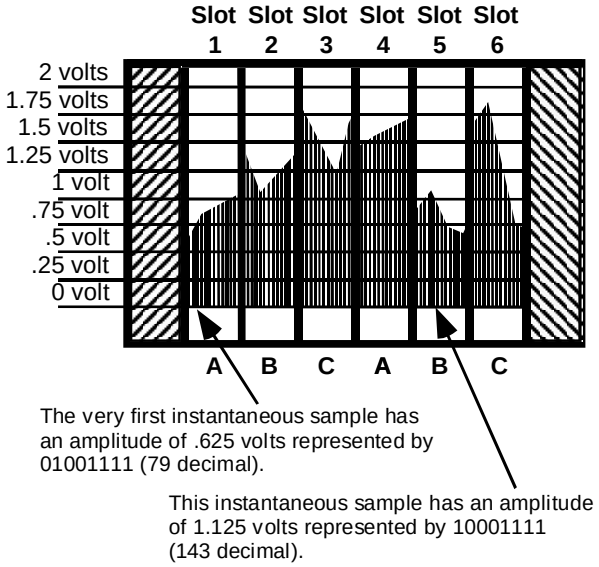
Figure 13. Slot Assignments



Digitization of Voltage

A byte, consisting of 8 bits, holds 256 possible numbers (0 through 255). If the maximum voltage we might expect from our voice samples is 2 volts, we can arbitrarily match those voltages proportionally to our byte. The result is a binary string representing voltages. We now have digital voice.

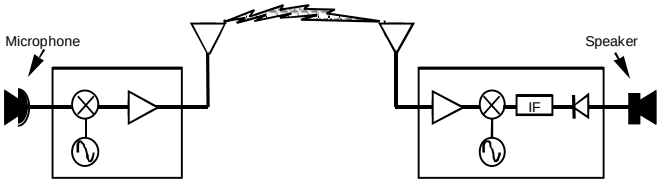
Figure 14. Digitization of Voltage



Conventional Radio

Radio uses transmitters to convert speech to radio energy and receivers to convert radio energy back to speech. In conventional analog radio, speech is converted into varying voltages called audio by a microphone. The

Figure 15. Convetional Radio



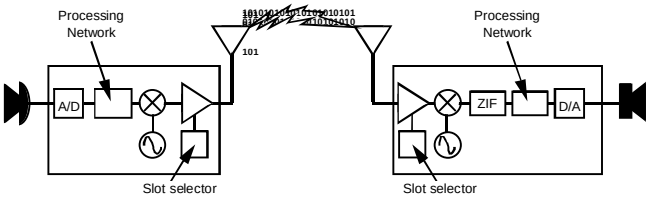
audio is mixed with a carrier frequency, amplified, and propagated through space as radio energy by an antenna. At the remote receiver an antenna converts the received radio energy to varying voltages at radio frequencies. The RF energy is beat against the output from a local oscillator to produce a difference frequency called the intermediate

frequency. The IF is processed in the IF strip, which provides filtering and amplification. A discriminator retrieves audio from the IF and the varying voltages of the audio are used to drive a speaker

TDMA Radio

TDMA radios use the same circuitry as analog radios, for the most part, but also have additional circuitry to convert analog audio to digitized form and vice versa, and to select the appropriate time slot.

Figure 16. TDMA Radio



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Accessories

STANDARD TRAVEL CHARGER SPN4474

- Charges battery in approximately 4-6 hours.
- Provides power to your phone while simultaneously charging your battery.
- Portable, small, and light enough to travel with.

LEATHER CARRY CASE SYN7435

- Case helps protect phone's surface from damage.
- Provides easy access to phone's keypad.
- Genuine leather provides a stylish look.

VEHICLE POWER ADAPTER SYN7753

- Provides virtually unlimited in-vehicle use.
- Conserves phone's battery power while simultaneously providing a rapid battery charge.

EASY INSTALL HANDS-FREE KIT SYN7820

- Portable kit plugs directly into phone and vehicle's cigarette lighter for quick and easy installation.
- Provides convenient hands-free communication on the go.
- Conserves phone's battery power while simultaneously providing a rapid battery charge.

RETRACTABLE HANDS-FREE HEADSET SYN8284

- Enjoy simple hands-free operation.
- Retractable headset and connector provide easy storage.
- Light weight.

OVER-THE-EAR STYLE HANDS-FREE HEADSET SYN8146

- Enjoy simple hands-free operation.
- Noise canceling microphone can reduce background noise.
- High quality speaker helps ensure excellent voice quality.

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HANDS-FREE HEADSET (JEWEL CASE) SYN7453
- Enjoy simple hands-free operation.
- One-piece design integrates microphone and earpiece.
- Convenient pocket-sized case for easy portability and storage.

HANDS-FREE HEADSET (BLUE POUCH) SYN6962
- Enjoy simple hands-free operation.
- One-piece design integrates microphone and earpiece.
- Convenient pocket-sized case for easy portability and storage.

HANG-UP CUP SYN7151
- Provides convenient location for in-vehicle use.
- Package includes hang-up cup and mounting hardware.

BELT CLIP SYN7158
- Connects phone to belt for easy wearability.
- Requires either a AA or AAA battery cover door with connector.

BELT CLIP BATTERY COVER DOOR PACKAGE SYN0003
- Includes one AA, one AAA battery cover door with belt clip connectors and belt clip.

SLIM NIMH AAA LONG BATTERY SNN5366
SLIM NIMH AAA BATTERY DOOR SHN6842
- Provides up to 100 minutes of talk time or up to 100 hours of standby time** when in digital mode.

EXTRA CAPACITY NIMH AA BATTERY SNN4934
EXTRA CAPACITY NIMH AA BATTERY DOOR SNN6841
- Provides up to 180 minutes of talk time or up to 180 hours of standby time** when in digital mode

*** The use of wireless devices and their accessories ("devices") may be prohibited or restricted in certain areas. Always obey the laws and regulations on the use of these devices.**
**** All talk and standby times are approximate and depend on network configuration, signal strength and features selected. Talk times and standby times are lower when in analog mode.**

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TDMA Easy NAM Programming

Introduction

The Number Assignment Module (NAM) is a section of memory that retains information about the phone's characteristics, such as the assigned telephone number, system identification number, and options information.

Two methods are available to program the NAM using the keypad: Test Mode and User Mode.

Regardless of the method used, the NAM must be programmed before the phone can be placed into service. This chapter covers the NAM Programming steps for Easy NAM Programming which is the preferred programming method

User Mode Programming

User Mode NAM programming requires a special key sequence to enter, but can be accomplished through the telephone keypad without the use of any specialized hardware.

The telephone number can be changed up to fifteen times, after which the phone must be reset in Manual Test Mode using the **32#** command (erasing all repertory memory and initializing counters).

Some models may be available with a "User Mode NAM Programming Manual" which describes the entry key sequences and the programming steps for User Mode NAM programming.

User Mode NAM programming steps are different from Test Mode NAM programming steps, and do not include all of the option bits available in Test Mode NAM programming.

Access to User Mode NAM programming can be disabled by Test Mode NAM programming step 11, bit C7. Detailed description on Test Mode NAM Programming can be found in the TDMA Test Mode Nam Programming section of this manual.

The following page describes the step by step procedure for Easy NAM Programming, which is the preferred programming method.

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Programming Sequence

Enter Programming Mode ❶ Press (#) , carrier system ID (from your Cellular Service Provider), (#) , (*) , (snd) . Phone displays " NAM 1 Prog * = Yes # = No".

❷ Press (*) . Display prompts for Security Code "_ _ _ _ _ _".

Enter Security Code ❸ Press (0+) , (0+) , (0+) , (0+) , (0+) , (0+) (factory set). Phone displays ESN (Electronic Security Number).

❹ Press (snd) . Phone prompts for Phone Number " Phon # _ _ _ _ _ _ _ _ _ _".

Enter Phone Number ❺ Enter the entire Phone Number "_ _ _ _ _ _ _ _ _ _". Press (SEND) Phone displays " NAM Program Begins ".
The phone will turn off. When you turn the phone back on, the phone number will be programmed.

Programming a second No. Press (#) , carrier system ID , (#) , (2ABC) , (#) , (*) , (SEND) .
Continue with steps ❷ - ❺ .
Be sure to check with the carrier of the second telephone number for the system ID.

If you make a mistake Try again will appear and you can re-enter the number. Press (CLR) to erase a single digit or press and hold (CLR) to erase the entire entry. Press (snd) when you are finished.

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TDMA Test Mode NAM Programming

Introduction

The Number Assignment Module (NAM) is a section of memory that retains information about the phone's characteristics, such as the assigned telephone number, system identification number, and options information.
Two methods are available to program the NAM using the keypad: Test Mode and User Mode.

Regardless of the method used, the NAM must be programmed before the phone can be placed into service. This chapter covers the NAM Programming steps for Test Mode NAM Programming.

Entering Test Mode NAM Programming

The recommended Manual Test Mode setup for NAM programming phones are described in "Entering Manual Test Mode" on page 33. Refer to "Test Connections" on page 38 to see the recommended test setup for performing Servicing Level manual tests.

The phone is in Status Display mode after powering up in Manual Test mode. To enter NAM Programming mode, first press the # key for at least two seconds to suspend the Status Display. Then enter 5 5 #. The phone will now be in Step 1 of the NAM.

NAM Programming Steps

There are 19 steps in the NAM. For each step, the display shows factory default NAM data. When new data is entered via the keypad the display scrolls from left to right.

Use the * key to sequentially step through the NAM data fields, entering new data as required, or skipping past factory default values for parameters that do not need to be changed.

Table 7, "Minimum Required Test Mode NAM Programming Steps", shows the minimum required Test Mode NAM programming steps. The programming steps not listed in this table can be "stepped through", retaining the factory default values for those steps.

Table 8, "Test Mode NAM Programming Sequence," on page 3 lists all NAM programming steps, complete with parameters and definitions.

Table 7. Minimum Required Programming Steps

Service Type	Minimum Required Programming
Single NAM	1, 3, 4, 6, 9
Dual NAM Enable	11
Dual NAM	1, 3, 4, 6

NAM Data

NAM Data is specified by the system operator. For most NAM steps, the information specified by the system operator is the same as the factory default data.

The factory default System ID (step 01) and User Telephone Number (step 03) must always be changed.

Other portions of the factory default NAM data must sometimes be modified to conform to special system requirements, or to enable/ disable certain features.

If a second phone number is to be programmed, step 11 C Option Byte, bit 6 must be set to 1. This bit enables dual-NAM operation and will cause NAM program-ming steps 1-6, 12, and 16 to be repeated for the second phone number.

User Mode Programming

User Mode NAM programming requires a special key sequence to enter, but can be accomplished through the telephone keypad without the use of any specialized hard-ware. The telephone number can be changed up to fifteen times, after which the phone must be reset in Manual Test Mode using the 32# command (erasing all repertory memory and initializing counters).

Some models may be available with a "User Mode NAM Programming Manual" which describes the entry key sequences and the programming steps for User Mode NAM programming.

User Mode NAM programming steps are different from Test Mode NAM programming steps, and do not include all of the option bits available in Test Mode NAM programming. Access to User Mode NAM programming can be disabled by Test Mode NAM programming step 11, bit C7.

NOTE

Changed NAM values are not stored until pressing ***** after Step 19 (Step 16 if a second phone number was entered.)

IMPORTANT

Consult with the System Operator regarding NAM information. Incorrect
NAM entries can cause the phone to

Test Mode NAM Programming Sequence

Advances to the next programming step; also programs the NAM after the last programming step is entered.

Clears the entered information and displays previously entered data for the current programming step.

Exits the programming mode without programming the NAM.

Table 8. Test Mode NAM Programming Sequence

Step	Factory Default	Description
01	00000	**System ID Number**. Number assigned by system operator for system identification.
02	10110101 (A7-A0)	**A OPTION BYTE.** The display for step 02 represents the status of eight options, A7 through A0. Bit A7 (msb) is programmed first, followed by A6-A0. Bits enter display on the right and scroll left.
	1	**Local Use (Bit A7).** If set to 1 phone will respond to local control orders in the home area or when the group ID is matched. Assigned by system operator.
	0	**Preferred System (Bit A6).** Applies to units capable of operating on two service systems (A or B). 0 = system B; 1 = system A.
	1	**End-to-End Signaling (Bit A5).** When enabled, the phone is equipped for DTMF signaling during a call. 1 = enabled, 0 = disabled.
	1	**Authentication Enable (Bit A4).** Enter 1.
	0	**Bit not used (Bit A3).** Enter 0.
	1	**Auxiliary Alert (Bit A2).** When enabled, the user can place an Extended System in auxiliary alert mode and be notified of incoming calls via headlights, horn etc. 1 = enabled, 0 = disabled.
	0	**Bit not used (Bit A1).** Enter 0.
	1	**MIN MARK (Bit A0).** Supplied by system operator. When enabled the user's area code will be sent with each call initiated or answered. 1 = enabled, 0 = disabled.
03	0000000000	**User 10 digit radiotelephone phone number.** Number is assigned by system operator.
04	00	**Station class mark.** A 2 digit number assigned by the system operator. Indicates maximum power step, VOX capability, and number of channels used.
05	00	**Access overload class.** Specifies the level of priority assigned to the phone when accessing the system. Assigned by system operator.
06	00	**Systems group ID mark.** Specifies how many bits of the system ID are compared during call processing. Assigned by system operator.

Table 8: Test Mode NAM Programming Sequence (con't)

07	000000	**Security code.** A 6 digit number supplied by the user. This number is used by the user to access or change "security" features such as the 3-digit unlock code or the service level.
08	123	**Unlock code.** A 3 digit number supplied by the user. If the lock feature is enabled by the user, the phone can be operated only by individuals who know the unlock code.
09	4	**Service level.** This 3 digit number supplied by the user allows various call placement restrictions if desired. 004 = no restrictions.
10	00000100 (B7-B0)	**B OPTION BYTE** The display for step 10 represents the status of eight options, B7 through B0. B7 (msb) is programmed first followed by B6-B0. Bits enter display on the right and scroll left.
	0	**Bit not used (Bit B7).** Enter 0.
	0	**Bit not used (Bit B6).** Enter 0.
	0	**Bit not used (Bit B5).** Enter 0.
	0	**Bit not used (Bit B4).** Enter 0.
	0	**Single System Scan (Bit B3).** If set to 1, phone will scan only one system based on the setting of the preferred system bit (option bit A6). 1 = enabled, 0 = disabled.
	1	**Auto Recall (Bit B2).** When set to one, the user may access repertory by a one or two digit send sequence (speed dialing).
	0	**Disable Service Levels (Bit B1).** If set to 1, the service level (call restrictions) cannot be changed by the user.
	0	**Lock Disable (Bit B0).** When set to 1, the user cannot lock and unlock the phone unit via the 3 digit lock code.
11	00001000 (C7-C0)	**C OPTION BYTE** The display for step 11 represents the status of eight options, C7 through C0. C7 (msb) is programmed first followed by C6-C0. Bits enter display on the right and scroll left.
	0	**User Mode NAM Programming Disable (Bit C7).** When set to 1, User Mode NAM programming cannot be accessed.
	0	**Second Number Registration (Bit C6).** When set to 1, allows access to the second phone number.
	0	**Bit not used (Bit C5).** Enter 0.
	0	**Auto Redial Disable (Bit C4).** When set to 1, the user cannot access the 6-minute auto redial feature.
	1	**Speaker Disable (Bit C3).** This bit is used to disable internal handset speaker when adding V.S.P. option. 1 = handset speaker disabled, 0 = handset speaker enabled.
	0	**Bit not used (Bit C2).** Enter 0.
	0	**Selectable System Scan Disable (Bit C1).** When set to 1, the user cannot select the primary system.
	0	**Diversity Antenna Enable (Bit C0).** (Extended systems only) 0 = Non-diversity, 1 = Diversity.
12	0334	**Initial Paging System.** There are 4 significant bits for the initial paging channel. For system A enter 0333 and system B enter 0334.

Table 8: Test Mode NAM Programming Sequence (con't)

13	0333	**Initial A system channel.** To initialize system A enter 0333.
14	0334	**Initial B system channel.** To initialize system B enter 0334.
15	021	**Dedicated Paging Channels.** Number of dedicated paging channels is 21. Enter 021.
16	0737	**Secondary Initial Paging System.** There are 3 significant bits for the secondary initial paging channel. For system A enter 708 and system B enter 737. . Secondary initial paging channels are for digital applications, providing a secondary scan for a digital channel.
17	0708	**Secondary Initial A system channel.** To initialize system A enter 708.
18	0737	**Secondary Initial B system channel.** To initialize system B enter 737.
19	10111011	**D Option Byte.** The display for step 16 represents the status of eight options, D7 through D0. D7 (msb) is programmed first, followed by D6-D0. Bits enter display on the right and scroll to left.
	1	**Enhanced Scan Enable (Bit D7).** Enter 1.
	0	**Cellular Connection Enable (Bit D6).** Normally set to 0.
	1	**Long Tone DTMF Enable (Bit D5).** Normally set to 1.
	1	**Transportable Internal Ringer/Speaker Disable (Bit D4).** When set to 0, audio is routed to the accessory speaker of the transportable. When set to 1, audio is routed to the handset speaker. Normally set to 1.
	1	**Eight Hour Time-out Disable (Bit D3).** Normally set to 0.
	0	**Handset Test Mode Disable (Bit D2).** Enter 0.
	1	**Failed Page Indicator Disable (Bit D1).** When set to 1, the failed-call tone alert feature is disabled.
	1	**Word Sync Scan Disable (Bit D0).** Enter 1.

NOTE

If the second phone number bit is enabled, (step 11 C Option Byte bit 6), then steps 1- 6, 12, and 16 are repeated.
To store NAM data press the * key until the 'is displayed after step 19

Manual Test Mode

Introduction

Manual Test Mode software allows service personnel to monitor the telephone status on the display, and manually control tele-phone functions via the keypad.

Manual Test Mode operates at two levels: 1) Status Display level, which allows the phone to operate normally while providing status indications in the display; and 2) Servicing Level, which disables normal call-processing and allows commands to be entered through the keypad to manually control operation of the phone.

Entering Manual Test Mode

Manual Test Mode is entered by entering the following keypad sequence:

FCN 0 0 * * T E S T M O D E STO

Once this key sequence is completed the Status Display screen appears. Press and hold the # key for 2 seconds to enter in manual test mode.

Figure 19: "Connections for PCS Testing" on page 38 shows the recommended test setup.

Status Display Level

Status Display level is the power-up state in manual test mode. In this level of manual test mode the phone will place and receive calls as normal, but the display shows two lines of status information.

The display alternates between the channel number, RSSI status information, and primary status information:

- SAT frequency
- Carrier state
- Signaling tone state
- Power level
- Voice/data channel mode
- Audio states
- DVCC and BER measurements

The format of this status information is shown in Figure 17: "Test Mode Status Display (Analog Mode)" on page 35 and Figure 18: "Test Mode Status Display (Digital Mode)" on page 36.

When dialing a phone number, the status display ceases when the first digit of the phone number is entered. The telephone number is then displayed as it is entered. When the Snd, End, or Clr button is pressed, the status information display resumes. The phone remains in Status Display Mode if the # key is pressed momentarily.

Servicing Level

The Servicing Level of Manual Test Mode allows service personnel to manually control operation of a phone by entering commands through the telephone keypad. Parameters such as operating channel, output power level, muting, and data trans-mission can all be selected by entering the corresponding commands.

To enter the Servicing Level, press and hold the # button for at least 2 seconds while in Status Display level (power-up state of manual test mode.)

In the Servicing Level, automatic call processing functions are disabled, and the phone is instead controlled manually by keypad commands.

Table 3, "Test Commands For Manual Test Mode," on page 23 lists the commonly used manual test commands and the resulting display and telephone function for each command.

Figure 17. Test Mode Status Display (Analog Mode)

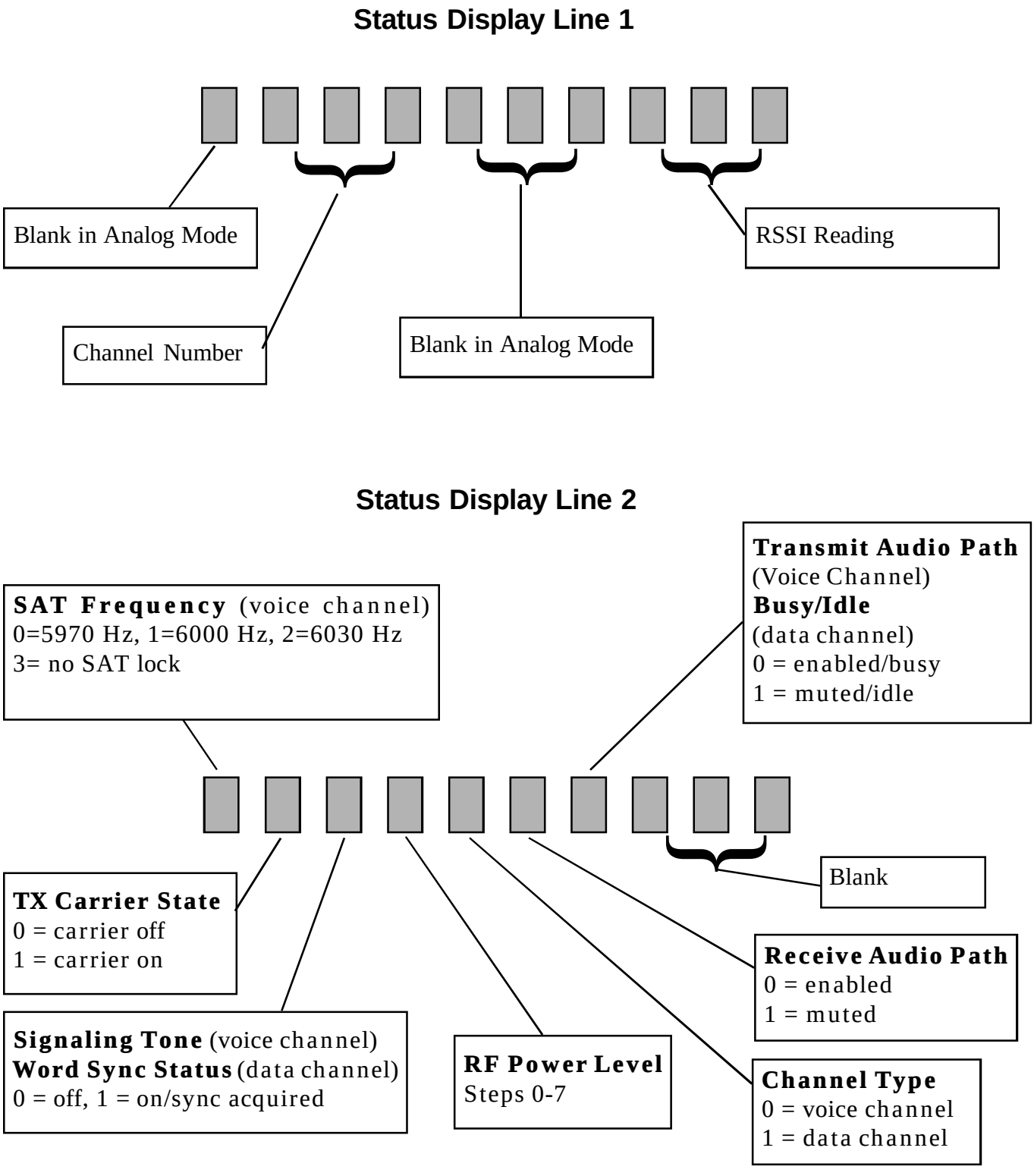
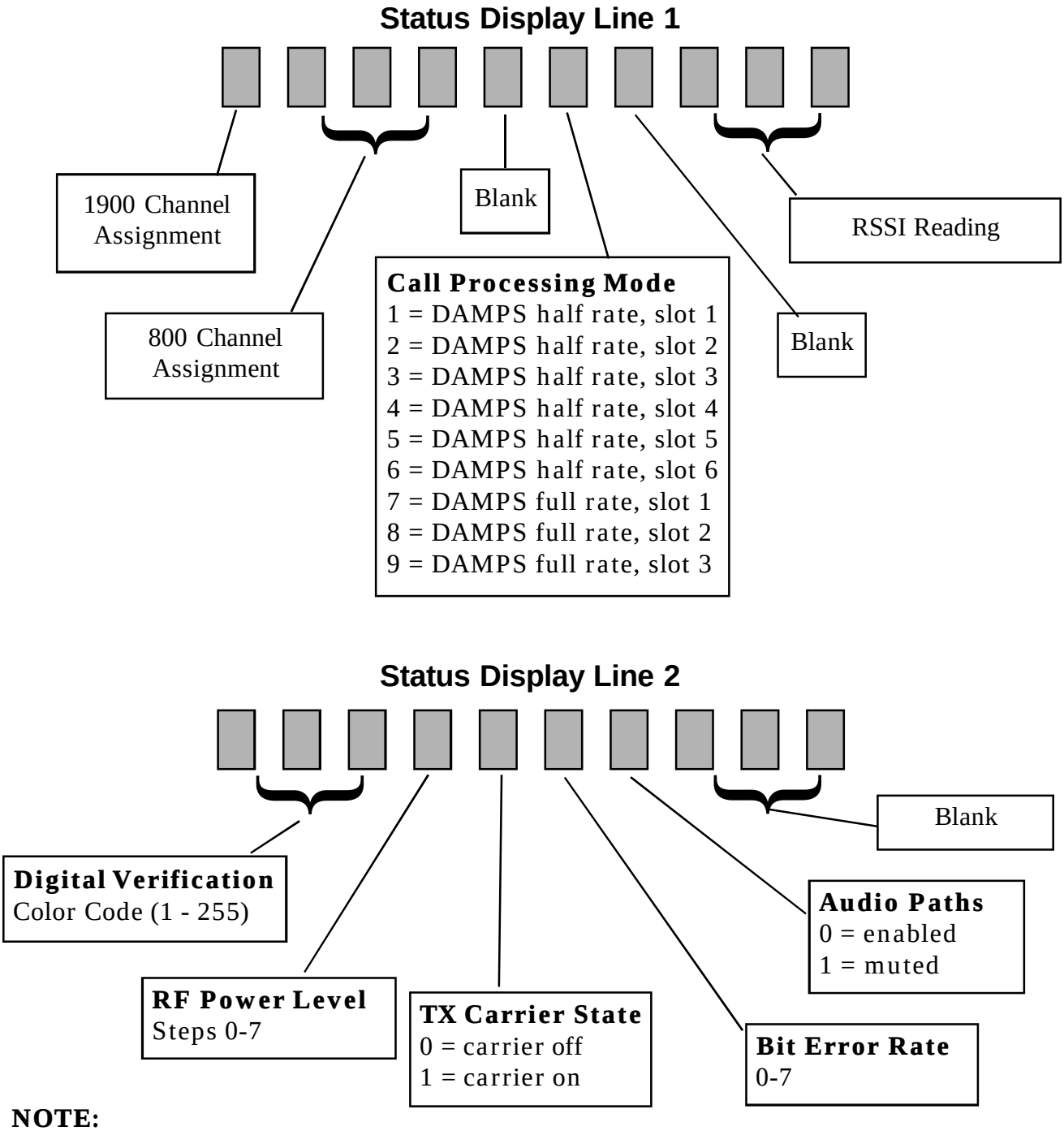


Figure 18. Test Mode Status Display (Digital


Status Display Line 1
1900 Channel Assignment
800 Channel Assignment
Blank
Call Processing Mode
1 = DAMPS half rate, slot 1
2 = DAMPS half rate, slot 2
3 = DAMPS half rate, slot 3
4 = DAMPS half rate, slot 4
5 = DAMPS half rate, slot 5
6 = DAMPS half rate, slot 6
7 = DAMPS full rate, slot 1
8 = DAMPS full rate, slot 2
9 = DAMPS full rate, slot 3
Blank
RSSI Reading
Status Display Line 2
Digital Verification
Color Code (1 - 255)
RF Power Level
Steps 0-7
TX Carrier State
0 = carrier off
1 = carrier on
Bit Error Rate
0-7
Audio Paths
0 = enabled
1 = muted
Blank

NOTE:
800MHz channels are displayed as three digits. Channel Numbers 1000-1023 are represented on the display as A00-A23.
1900MHz channels are displayed as four digits (0002 to 1998).

Test Procedures

Introduction

The phone allows keypad controlled testing of various analog and digital operating parameters.

This chapter includes the keypad button functions and recommended equipment setup to use when testing a phone.

Automatic Call-Processing Tests

Most communications analyzers can simulate a cell site in order to perform automatic call-processing tests. Automatic call processing tests can be performed while the phone is in its power-up state. However, it is useful to do the tests with the phone in Test Mode Status Display.

Refer to the communications analyzer's manual for details about performing call-processing tests. The following call-processing test sequence is recommended:

1. Inbound call, analog mode
2. Outbound call, analog mode
3. Analog-to-Analog channel handoff
4. Analog-to-Digital channel handoff
5. Inbound call, digital mode
6. Outbound call, digital mode
7. Digital-to-Digital channel handoff
8. Digital-to-Analog channel handoff

Handoffs should be performed between low, middle, and high frequency channels, such as, 991 (lowest frequency), 333 (middle frequency), and 799 (highest frequency). In digital mode slots 1 & 4, 2 & 5, and 3 & 6 should be verified.

Analog Test Measurements

- RX Sensitivity (SINAD)
- RX Audio Distortion
- TX Power Out
- TX Frequency Error
- TX Audio Distortion
- TX Maximum Deviation
- TX SAT Deviation
- TX ST Deviation

Digital Test Measurements

- Digital RX Sensitivity (BER)
- Digital Power Out
- TX Frequency Error
- Digital Modulation Stability (EVM)

The analog and digital parameters are stored in EPROM on the Transceiver Board. Each transceiver is shipped from the factory with these parameters already calibrated. However, if a board is repaired, these parameters should be measured and, if necessary, adjusted. Checking and adjusting calibration parameters is also useful as a troubleshooting/diagnostic tool to isolate defective assemblies.

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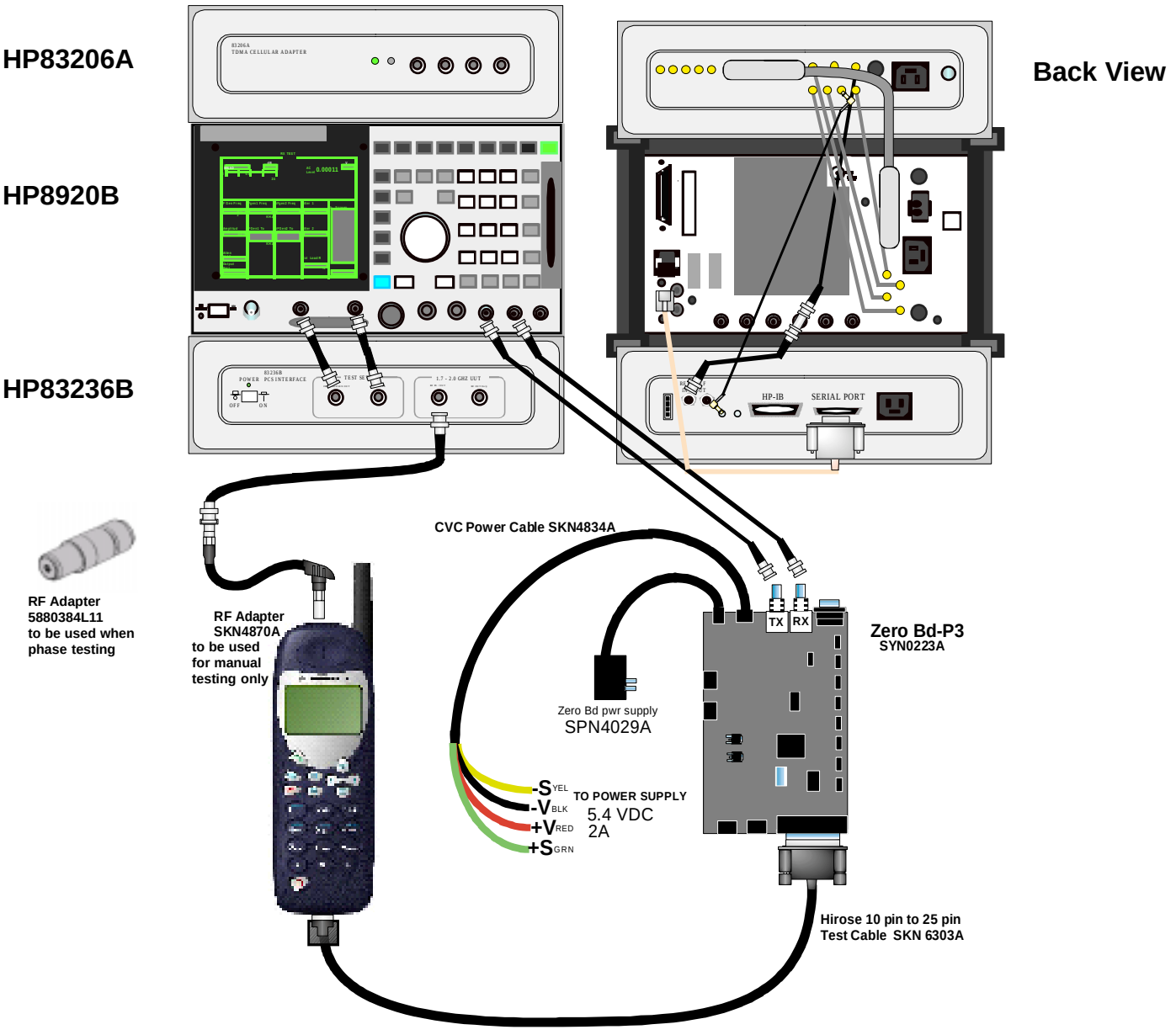
Test Connections

The diagram below shows the recommended connections for PCS testing when using the HP83236B PCS Interface with the HP8920B via Serial Port. Make sure to set the **HP-IB/ Ser** switch of the HP-IB Address Selector on the rear panel of the PCS Interface to "**Ser**."

The Zero Board test interface and an RF adapter with a low loss RF cable is used to interface with the communications analyzer.

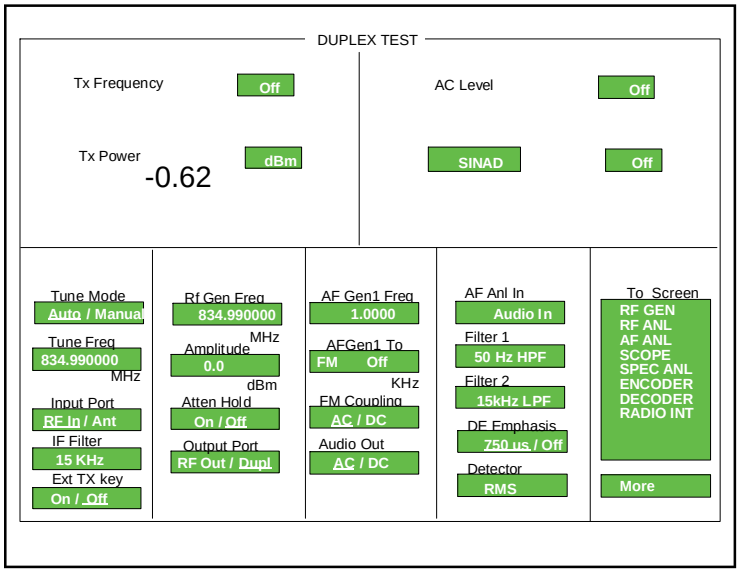
A variety of communications analyzers may be used. Refer to the analyzer manufacturer's user manual for proper setup before starting tests.

Figure 22. Connections for PCS Testing



RF Cable Test

Figure 20. Duplex Test Screen



To test the RF cable for proper loss:

- **Tune Freq** should be set to TX frequency: 834.990000 MHz.
- **RF Gen Freq** should be set to same frequency (834.990000 MHz).
- **Tx Power** should be set to read in dBm, not Watts.

In order to properly measure and adjust the parameters of a telephone, it is important that you use RF cabling that has minimal loss. Therefore, it is important that you test the RF cable for proper loss. This can easily be done by using the DUPLEX TEST screen of your HP8920. To test the cable, set up the DUPLEX screen as shown above.

Action:

Take the cable under test and connect it from the RF in/out port to the Duplex Out port. At this point you will be getting some type of power reading for cable loss.

Good range: -.2 dBm through -.8 dBm

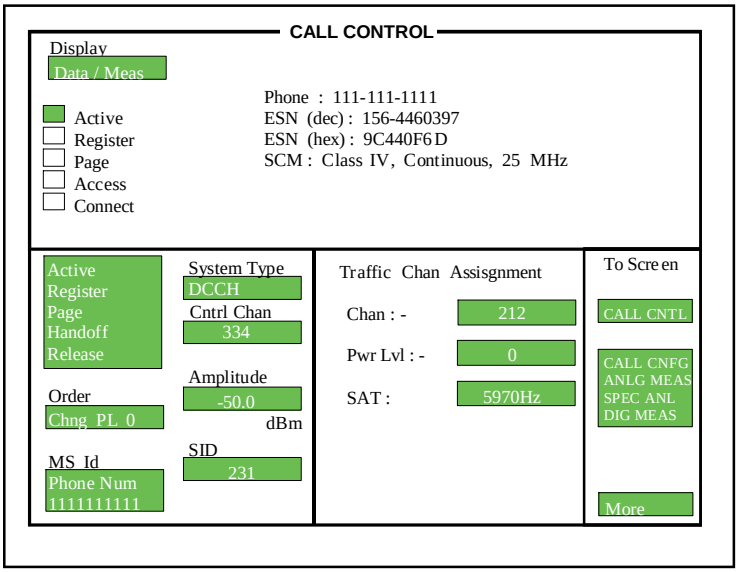
Bad cable: More than -.8 dBm

If the reading you are getting shows gain (positive number,) you may need to zero the power meter. This may happen on an HP8920 whose memory has just been cleared.

To zero the meter, press the **TX** button on the 8920 panel. Bring the cursor down to the field under **TX Pwr Zero** where it reads **Zero**. Tap the cursor on the Zero field and it will highlight for a moment as it zeroes the meter. Set up the screen as shown above, and test your cable.

Set up for Analog call

Figure 21. Call Control Screen



Select CALL CNTL from the To Screen

- Select System type: **AMPS**
- Zero the RF Power meter in the: **Call Config Screen**
- Set Amplitude to: **-50 dBm**
- Set SID: **Your phone's System ID**
- Select: **Active**
- **Voice Channel Assignment Type:**
- Chan: **212**
- Pwr Lvl: **4**
- SAT: **5970Hz**

Registration

1. Put the Test Set in Active state by selecting **Active** from the list on the left side of the screen.
2. Select **Data** from the **Data/Meas** field. This is the default mode.
3. Select **Register** from the list to register phone.
4. If the registration message has been received, the Test Set will display registration data in the upper half of the screen as shown in the sample screen above.

Page

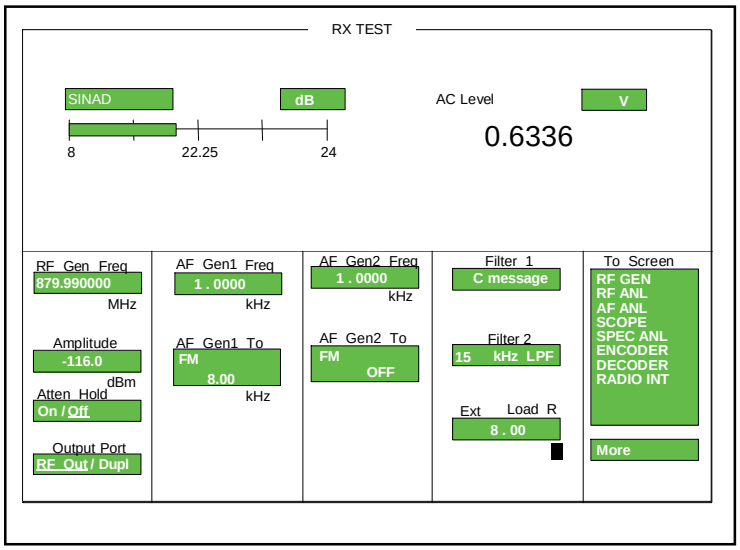
1 Select page from the list on the left side of the screen.
2 If the mobile responds, you will see the Access annunciator light briefly.
3 Answer the call by raising the flip or press SEND on the mobile to start the conversation.
4 The Connect annunciator lights. This is the Connect state.

Origination

1 Dial the desired phone number on the mobile station and press SEND.
2 The Access annunciator will light while the Test Set signals the mobile on the assigned voice channel.
3 The connect annunciator will light if the mobile properly signals the Test Set.

RX Sensitivity Test (SINAD)

Figure 22. RX Test Screen



Test Mode Commands:

11333#	Loads synthesizer to channel 333
08#	Unmute receive audio path
58#	Turn on compandor
474#	Set volume control to level 4
356#	Set RX audio path to Ext. Audio Path

Sinad measured on the communications analyzer must be between 13dB - 35dB.

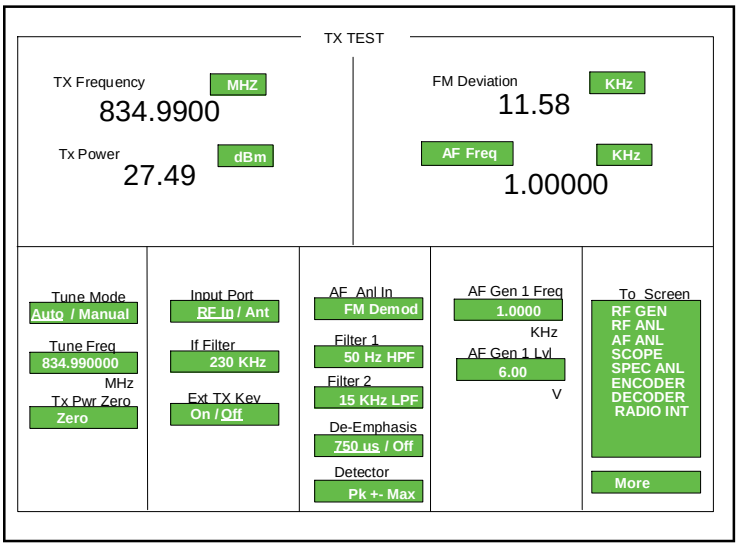
Duplex SINAD can be measured with the same setup by entering 122# and the 05# test command, which turns on the transmitter at power step 2. Narrow band SINAD can be measured by entering 571# and setting the FM Deviation to 3kHz. Refer to the RX troubleshooting section for radios not within the pass specifications.

Communications Analyzer Setup:

- Select **RX** button from the Screen Control panel
- Set **RX frequency** to **879.990 MHz**
- Set **Amplitude** to **-116 dBm**
- Set **AF gen1** to **1 kHz frequency** at **8 kHz deviation**, using **FM modulation** (PLEASE NOTE: this is for AMPS only; NAMPS uses much lower deviation)
- Set **AF Filter 1** set to **C message filtering**
- Set **AF Filter 2** to **15 kHz**

TX Power Out Test

Figure 23. TX Test Screen



Test Mode Commands:

11333#	Loads synthesizer to channel 333
12X#	Set power level to step X, where X is a power level from 1 to 7.
05#	Turns on transmit carrier

The TX Power Out specification for each portable power level is as follows:

Power Step 2	25dBm - 26dBm
Power Step 3	20.5dBm - 23.5dBm
Power Step 4	17.0dBm - 20.0dBm
Power Step 5	13.0dBm - 16.5dBm
Power Step 6	9.0dBm - 12.5dBm
Power Step 7	5.5dBm - 9.0dBm

Refer to the TX troubleshooting section for radios not within the pass specifications.

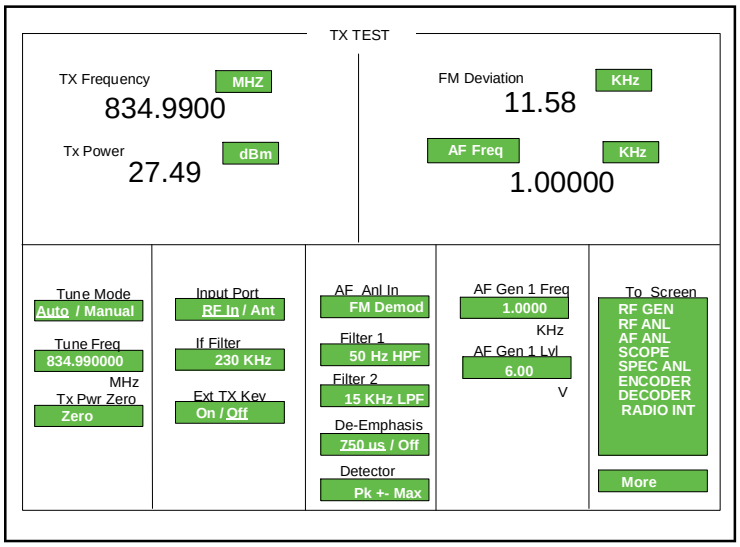
Note: When taking measurements, remember to compensate for cable loss.

Communications Analyzer Setup:

- **Select** TX **button from the Screen Control panel**
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

TX Frequency Error Test

Figure 24. TX Test Screen



Test Mode Commands:

11333#	Loads synthesizer to channel 333
122#	Set power level to step 2
05#	Turn on transmit carrier

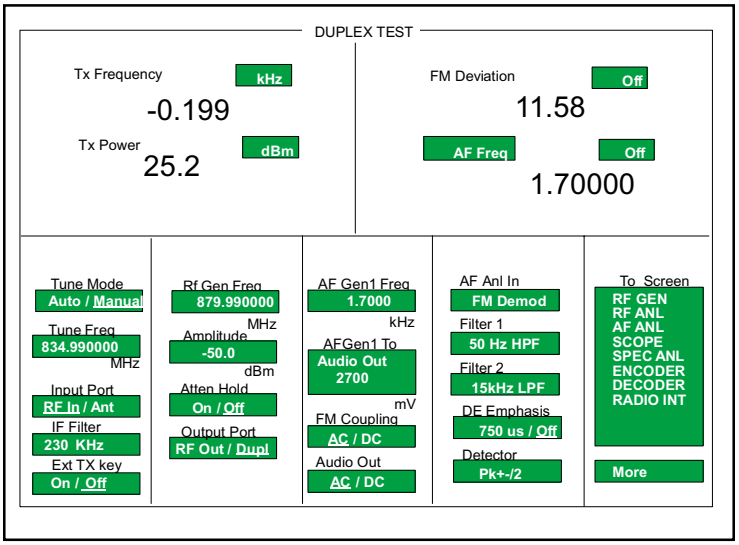
The frequency error measured on the communications analyzer must be less than ± 0.5 ppm .

Communications Analyzer Setup:

- **Select** TX **button from the Screen Control panel**
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

TX Maximum Deviation Test

Figure 25. TX Test Screen



Test Mode Commands:

11333#	Load synthesizer to channel 333
122#	Set power level to power step 2
05#	Turn on transmit carrier
356#	Select External TX Audio path
10#	Unmute TX Audio path
58#	Turn on compandor

View FM Deviation for reading.

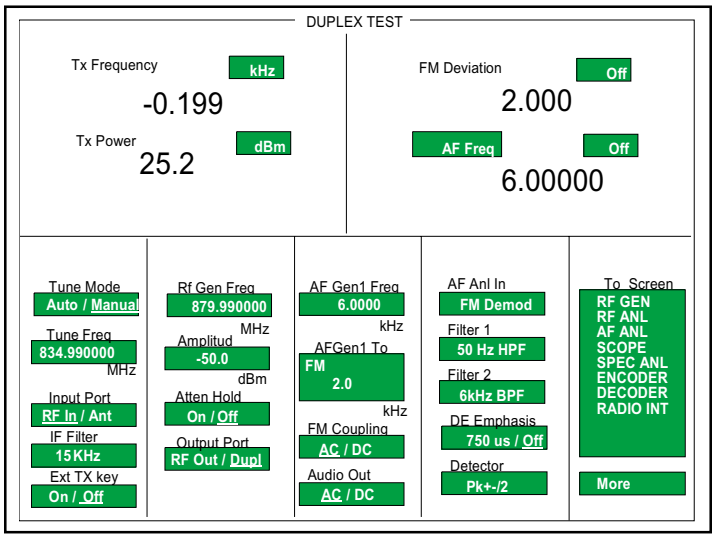
TX Maximum Deviation Pass Specifications: 10.5 kHz - 11.4 kHz.

Communications Analyzer Setup:

- Select **DUPLEX** button from the Screen Control panel
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **Tune freq** to **834.990000 MHz**
- Set **Input Port** to **RF In**
- Set **IF filter** to **230 kHz**
- Set **Ext TX Key** to **Off**
- Set **RF Gen Freq** to **879.990000 MHz**
- Set **Amplitude** to **-50 dBm**
- Set **Atten Hold** to **Off**
- Set **Output Port** to **Dupl**
- Set **AF Gen1 Freq** to **1.7000 kHz**
- Set **AF Gen1 To** to **Audio Out** and **2700 mV**
- Set **FM Coupling** to **AC**
- Set **Audio Out** to **AC**
- Set **AF Anl In** to **FM Demod**
- Set **Filter 1** to **50 Hz HPF**
- Set **Filter 2** to **15 kHz LPF**
- Set **DE Emphasis** to **Off**
- Set **Detector** to **Pk+-/2**

TX SAT Deviation Test

Figure 26. Call Control Screen



Test Mode Commands:

11333#	Load synthesizer to channel 333
122#	Set power level to power step 2
05#	Turn on transmit carrier
251#	Enable 6000 Hz SAT tone

View FM Deviation for the reading.

The transponded peak SAT FM deviation should be 1.9 kHz - 2.1kHz.

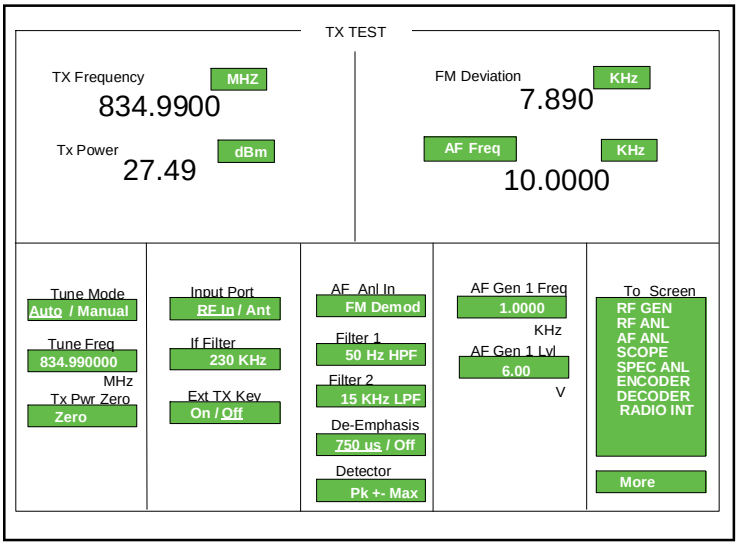
The demodulated signal on the communications analyzer should have an audio frequency of 6000 Hz.

Communications Analyzer Setup:

- Select **DUPLEX** button from the Screen Control panel
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **Tune freq** to **834.990000 MHz**
- Set **Input Port** to **RF In**
- Set **IF filter** to **15 kHz**
- Set **Ext TX Key** to **Off**
- Set **RF Gen Freq** to **879.990000 MHz**
- Set **Amplitude** to **-50 dBm**
- Set **Atten Hold** to **Off**
- Set **Output Port** to **Dupl**
- Set **AF Gen1 Freq** to **6.0000 kHz**
- Set **AF Gen1 To** to **FM** and **2.0 kHz**
- Set **FM Coupling** to **AC**
- Set **Audio Out** to **AC**
- Set **AF Anl In** to **FM Demod**
- Set **Filter 1** to **50 Hz HPF**
- Set **Filter 2** to **6 kHz BPF**
- Set **DE Emphasis** to **Off**
- Set **Detector** to **Pk+-/2**

TX ST Deviation Test

Figure 27. TX Test Screen



Test Mode Commands:

11333#	Load synthesizer to channel 333
122#	Set power level to power step 2
05#	Turn on transmit carrier
14#	Enable signaling tone

View FM Deviation for reading.

The ST deviation measured on the communications analyzer should be between 7.2 kHz - 8.2 kHz .

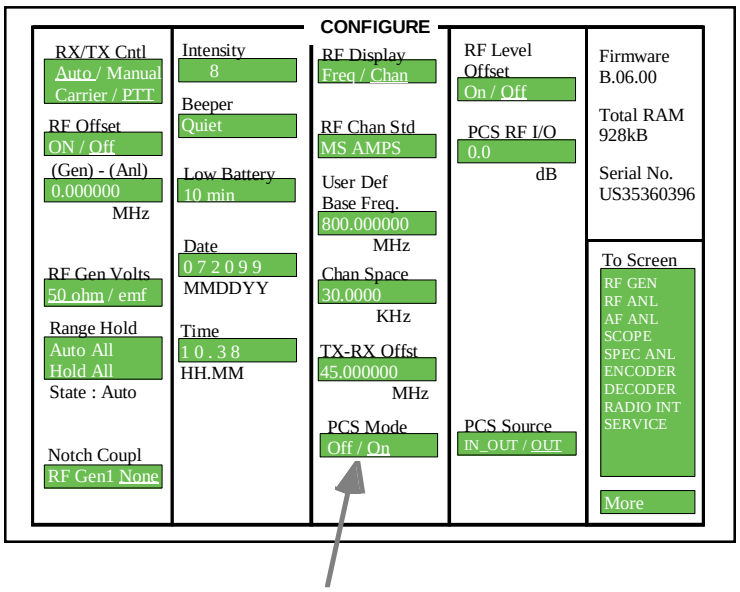
The demodulated signal on the communications analyzer should have an audio frequency of 10 kHz.

Communications Analyzer Setup:

- Select **TX** button from the Screen Control panel
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

Setting up for PCS TDMA Measurements

Figure 31. Configure Screen



Set PC Mode to “On”

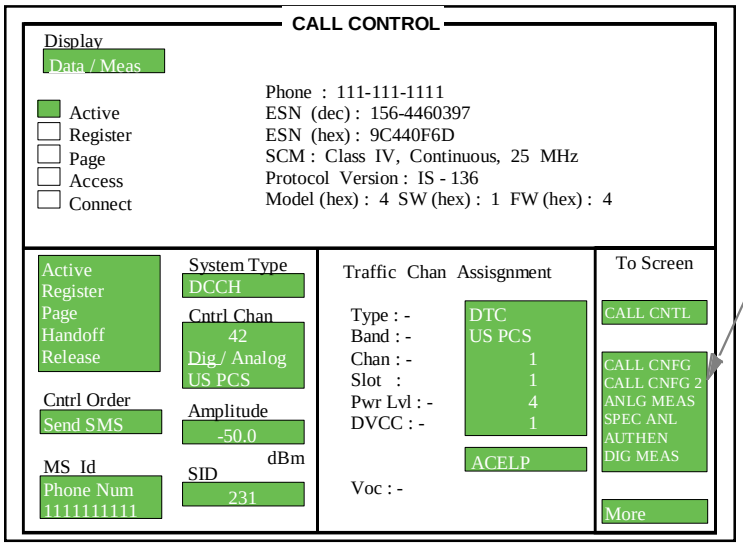
Power up the PCS Adapter, after two beeps are heard power up the 8920B

1 Go to the Configure screen on the 8920B (press blue shift key and then the Config/Duplex key).

2 Turn PCS mode to On.

3 Go to the Call Cntrl Screen by select ing More and then Call Cntrl from list.

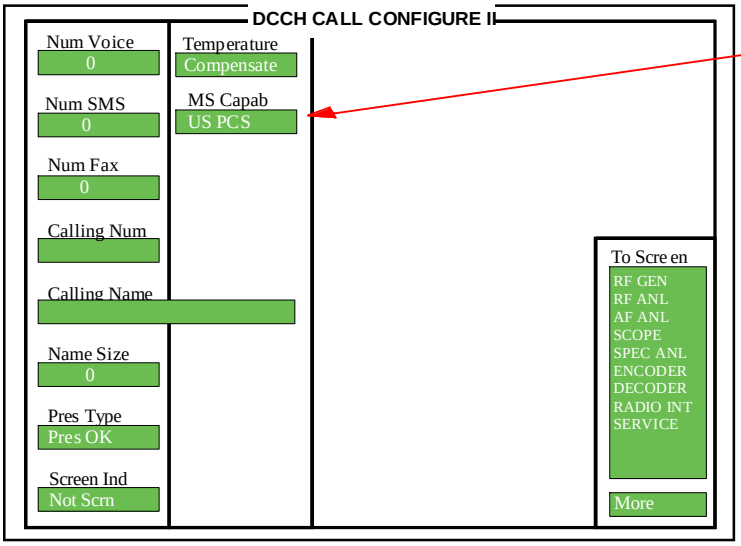
Figure 32. Call Control Screen



4 Select Call Config 2 Screen.

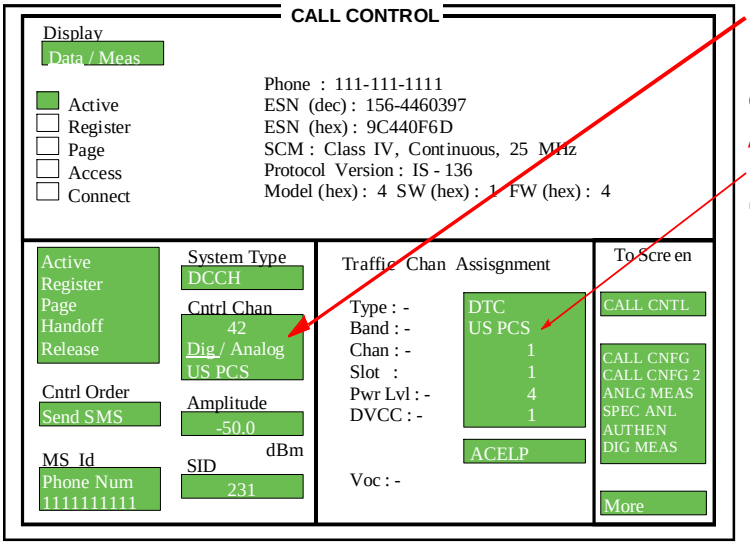
Setting up for PCS TDMA Measurements

Figure 30. DCCH Call Configure II Screen



5 In the MS Capab field select US PCS.

Figure 31. Call Control Screen

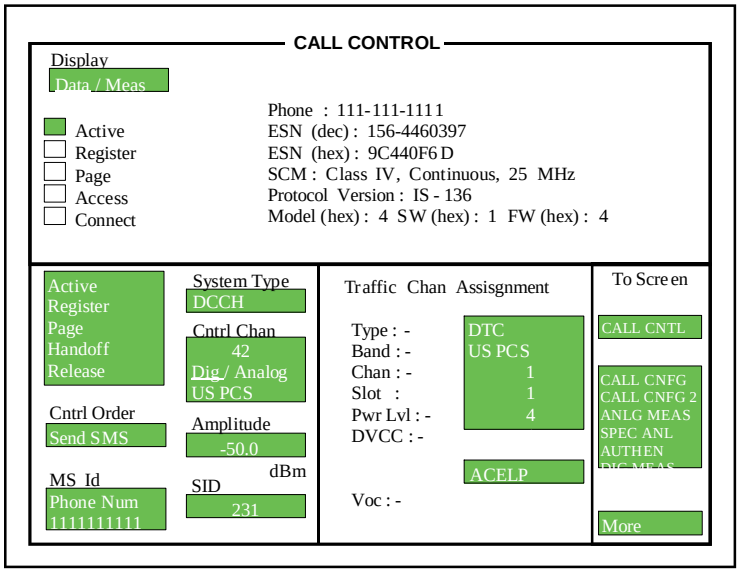


6 On the **Call Cntrl** Screen under the **Cntrl Chan** section select a digital control channel and select **US PCS** in the **Cellular / PCS** field.

7 On the **Call Cntrl** Screen under the **Traffic Channel Assignment** section in the **Band** field select US PCS.

Set up for TDMA call

Figure 32. Call Control Screen



Call Process

The following 4 steps need to be performed prior to beginning registration test:

1. Enter Test Mode using **FNC 0, 0, *, *, T, E, S, T, M, O, D, E, STO.**
2. Perform a 51# command in Test Mode to clear the Historic List. Turn off the telephone.
3. Connect the RF connector to the radio and power on.

Registration

1. Put the Test Set in Active state by selecting **Active** from the list on the left side of the screen.
2. Select **Data** from the **Data/Meas** field. This is the default mode.
3. Select **Register** from the list to register phone.
4. If the registration message has been received, the Test Set will display registration data in the upper half of the screen as shown in the sample screen above.

Select CALL CNTL from the To Screen

- Select System type: **DCCH**
- Zero the RF Power meter in the: **Call Config Screen**
- Set Amplitude to: **-50 dBm**
- Set SID: **Your phone's System ID**
- Select: **Active**
- **Traffic Channel Assignment Type:**
- Choose **DTC** to set up a Digital Traffic channel
- Type: **DTC**
- Chan: **1**
- Slot: **1**
- Pwr Lvl: **4**
- DVCC: **1**

Page

1 Select page from the list on the left side of the screen.

2 If the mobile responds, you will see the Access annunciator light briefly.

3 Answer the call by raising the flip or press SEND on the mobile to start the conversation.

4 The Connect annunciator lights. This is the Connect state. Data to be displayed is shown above.

Origination

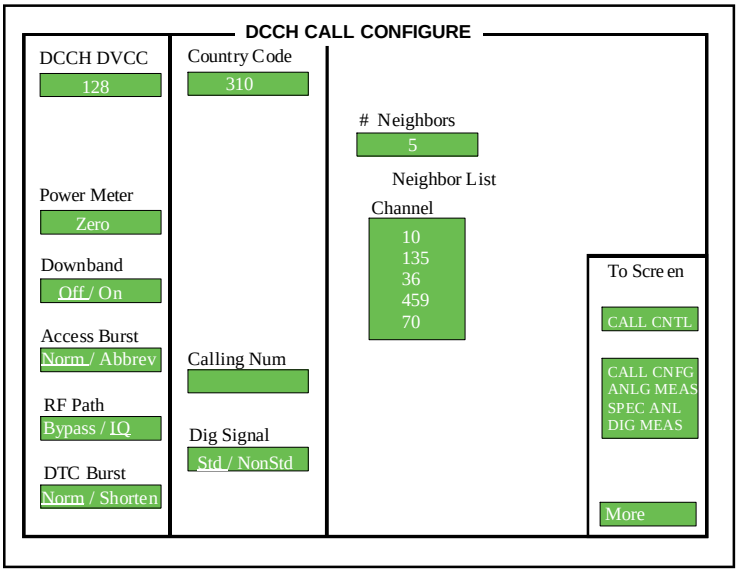
1 Dial the desired phone number on the mobile station and press SEND.

2 The Access annunciator will light while the Test Set signals the mobile on the assigned voice channel.

3 The connect annunciator will light if the mobile properly signals the Test Set.

MAHO Measurements

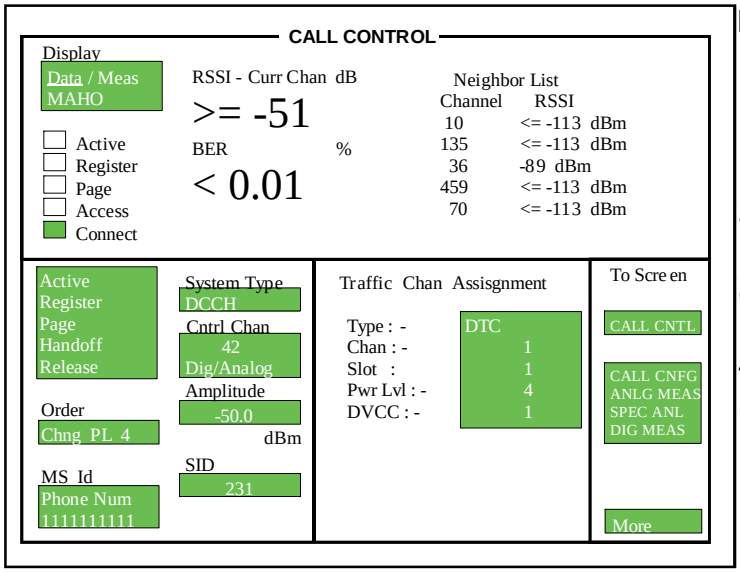
Figure 33. DCCH Call Configure Screen



Setting up the MAHO measurement

1 Select **CALL CNFG** from the CALL CONTROL's **To Screen.**
2 Set the number of neighbors (up to 6) with the field # Neighbors.
3 **Neighbor List Channel** fields ap pear below the **# Neighbors** field.
4 Set the channel number of each neigh bor channel.

Figure 34. Call Control Screen



Measuring MAHO

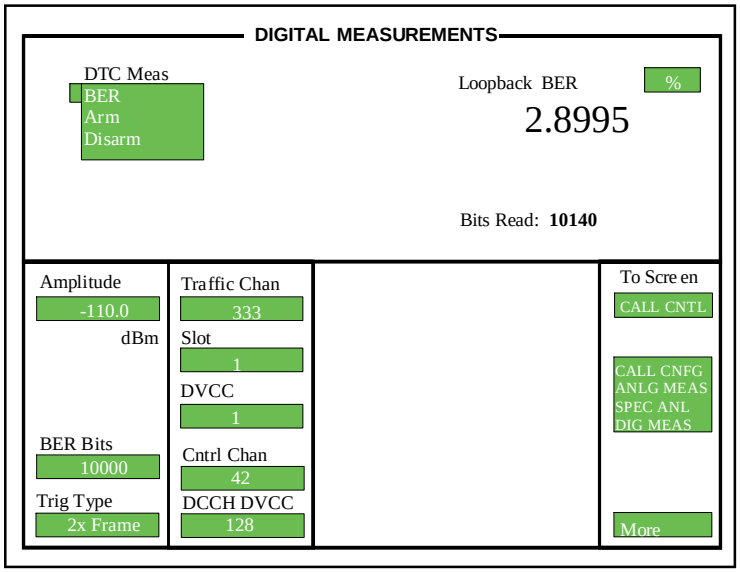
1 From **CALL CONTROL** screen, set up a call (Test Set must be in Connect mode).
2 Select **Meas** from the **Data / Meas** field.
3 Select the field that has appeared be low **Data / Meas.**
4 Select **MAHO** from the list of choices.
5 The **RSSI** and **BER** of the current channel are reported, as well as the **RSSI** of the designated neighbor chan nels.

MAHO (Mobile Assisted HandOff) is actually a measurement, not a handoff. The reported results are used by a base station to select the channel for the handoff.

The mobile performs the measurements, and them reports the results back to the base station. The mobile measures the **RSSI** of neighboring channels, as instructed by the base station. It also measures and reports the **RSSI** and **BER** of the current channel.

BER Measurements

Figure 35. Digital Measurements Screen



PCS Mode Handset Commands:

1 Enter 576# (Loopback mode)
2 11333# (Loads Synthesizer Channel)
3 Display prompt "Y" (enter desired time slot, for this test enter 1)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

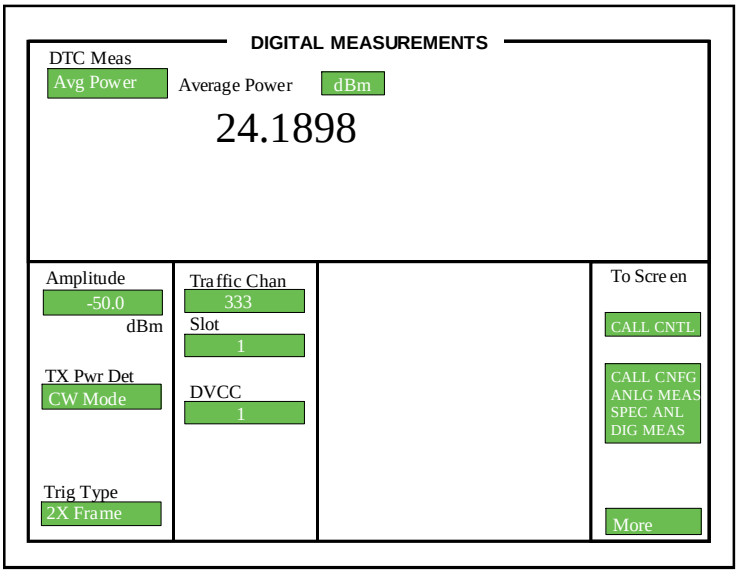
The BER measured on the communications analyzer must be less than or equal to **2%**.

BER Measurement Procedure

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen** menu.
3 Select the **DTC Meas** field to display a list of available tests.
4 Select **BER** from the list.
5 Enter the number of bits to be measured in the **BER Bits** field. (Note: the number of bits actually read will be calculated in whole frames.)
6 **Amplitude** should be set to -110 dBm.
7 **Traffic Chan** to 333.
8 **Slot** to 1.
9 **DVCC** to 1.
10 **Cntrl Chan** to 42.
11 **DCCH DVCC** to 128.
12 Put the mobile into test mode and enter the proper test commands for **BER** reading.
13 Select **ARM**.
14 After the actual number of bits has been transmitted and received, the **BER** should be displayed.

TX Power Measurements

Figure 36. Digital Measurements Screen



Digital TX Power Out Test Procedure

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen**.
3 Select the **DTC Meas** field. This shows the **To Screen** with a list of available tests.
4 Select **AVG Power.**
5 **Traffic Chan** should be set to 333.
6 Put the mobile into test mode.
7 Make Digital TX Power Out measure ments.

PCS Mode Handset Commands:

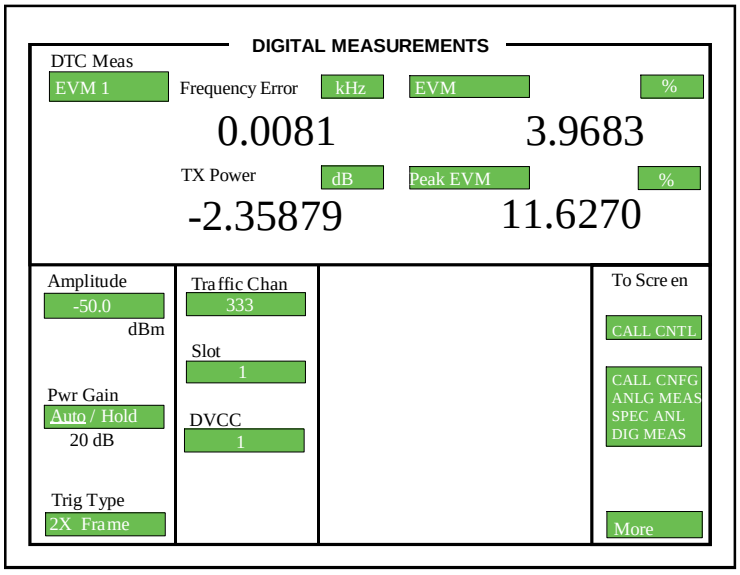
1 Enter 575# (Digital signaling mode)
2 11333# (Loads synthesizer Channel)
3 Display prompt "Y" (enter time slot)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

1900MHz Digital TX power step 2 specification is:
25.0 dBm - 27.0 dBm minus cable loss.

You can also use Digital Call processing to make these measurements.

TX Frequency Error Measurements

Figure 37. Digital Measurements Screen



TX Frequency Error Measurement Test

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen**.
3 Select the **DTC Meas** field. This shows the **To Screen** with a list of available tests.
4 Select **EVM 1**.
5 **Traffic Chan** should be set to 333.
6 Put the mobile into test mode.
7 Frequency error is displayed.

PCS Mode Handset Commands:

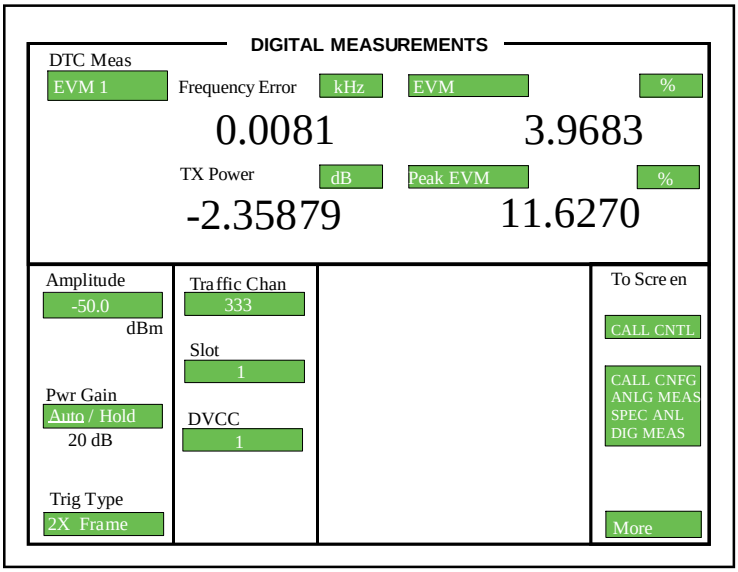
1 Enter 575# (Digital signaling mode)
2 11333# (Loads synthesizer Channel)
3 Display prompt "Y" (enter time slot)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

The frequency error measured on the communications analyzer must be **±200Hz**.

You can also use Digital Call processing to make these measurements.

EVM Measurements

Figure 38. Digital Measurements Screen



TX Frequency Error Measurement Test

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen**.
3 Select the **DTC Meas** field. This shows the **To Screen** with a list of available tests.
4 Select **EVM 1**. **EVM 10** can also be selected, it measures a 10 burst aver age.
5 **Traffic Chan** should be set to 333.
6 Put the mobile into test mode.
7 EVM is displayed.

PCS Mode Handset Commands:

1 Enter 575# (Digital signaling mode)
2 11333# (Loads synthesizer Channel)
3 Display prompt "Y" (enter time slot)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

The 10 burst average EVM measured should be less than or equal to **12.5%**.

You can also use Digital Call processing to make these measurements.

Disassembly

Introduction

Some troubleshooting and maintenance procedures for cellular phones require disassembly of the phone to gain access to internal components. Reasonable care should be taken to avoid damaging or stressing the housing and internal components during disassembly and reassembly.

Recommended Tools

The following tools are recommended for use during the disassembly and reassembly of the TDMA M3090/M3097

- Anti-Static Mat Kit (RPX-4307A); includes:
  - •Anti-Static Mat
  - •Ground Cord
  - •Wrist Band
- T7 Torx driver

CAUTION

Many of the integrated circuit devices used in this equipment are vulnerable to damage from static charges. An anti-static wrist band, connected to an anti-static (conductive) work surface, must be worn during all phases of disassembly, repair, and reassembly.

Battery Removal

1. Turn off the telephone.

2. While holding the phone firmly with one hand, use the index finger on the other hand to press the latch on the battery cover.

3. Slide the cover back to release it from the phone.

4. Use the thumb and index finger to grab the battery and pull it out of the telephone housing.

Antenna Removal

Use the thumb and index finger to remove the antenna using a counterclockwise twisting motion.

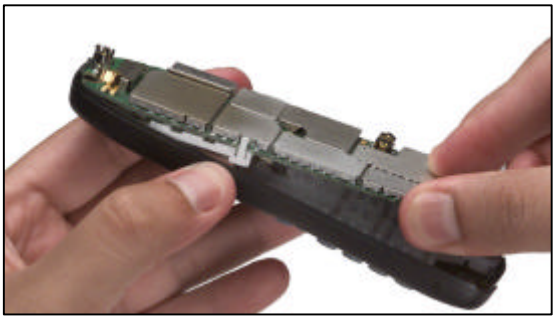
Back Housing Removal

1. Using a T7 Torx driver, unscrew the five torx screw that attach the back housing to the main body of the phone.

2. Carefully lift the back housing and pull it off the main assembly.

Transceiver Board Removal

1. While holding the phone firmly with one hand, use the thumb ,middle and index fingers of the other hand to carefully separate the transceiver phone from the main assembly.



Display Removal

1. Using the tweezers, lift the clip that holds the flex cable in place. Remove the flex cable from the clip.

2. Lift the latches that hold the display in place to separate the display from the main board.

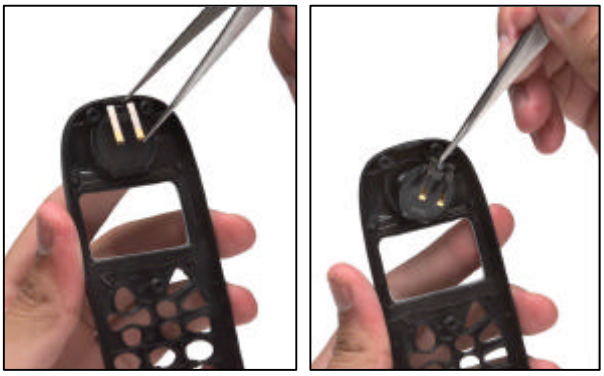
3. Carefully lift the display away from the main board.

Keypad Removal

1. Lift the keypad from the front housing using the thumb and index fingers.

Speaker Removal

1. Carefully pry off the speaker from the front housing using tweezers.



Parts List

Introduction

Motorola maintains a parts office staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Cellular products. Orders for all parts listed in this document should be directed to the following Motorola International Logistics Department:

Accessories and Aftermarket (AAD)
Schaumburg, IL, USA

Domestic
Customer Service: 1-800-422-4210
Hours: 7am - 7pm US Central Time

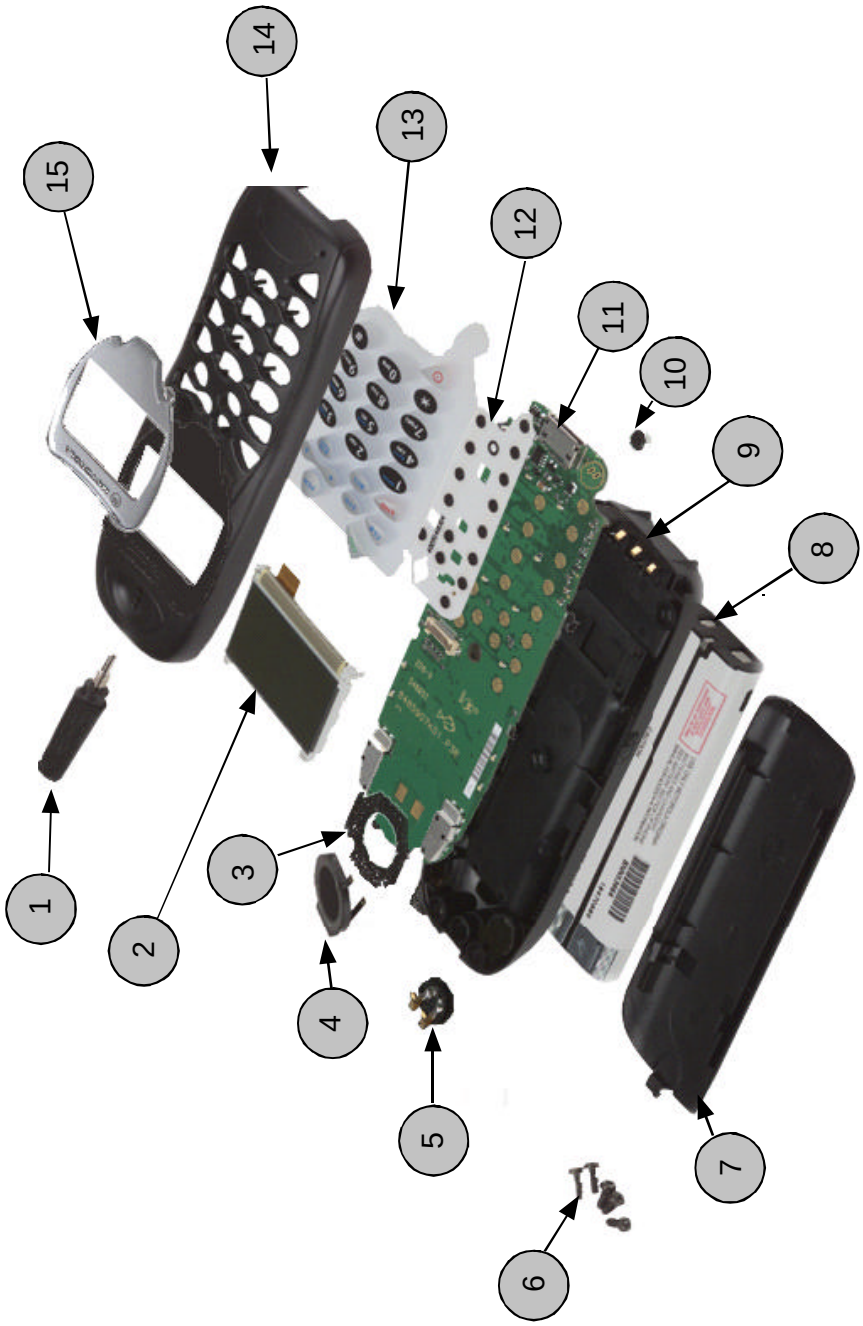
International
Customer Service: 1-847-538-8023
Hours: 8am - 6:30pm US Central Time

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Mechanical Explosion

The Mechanical explosion contains a table of mechanical part numbers that may change after publication of this manual. For an updated list of part numbers contact an AAD representative at the numbers listed above.

Figure 39. Mechanical Explosion



1	ANTENNA	8504892Z02	7A	AA BATTERY DOOR	SHN6841A	14	FRT. HOUSING	1587348K01	
2	DISPLAY	7204516Z02	8	BATTERY AAA	SNN5366A	15	LENS	6185716K01	
3	SPEAKER GASKET	3203997K01	9	REAR HSG.	0109482U06	16			
4	SPEAKER	5009150J04	10	MIC	5009536H15	17			
5	ALERT	5009005J09	11	RF BOARD	N/A	18			
6	SCREWS	0309315B02	12	MYLAR	4009410U04	19			
7	AAA BATTERY DOOR	SHN6842A	13	KEYPAD	3887349K01	20			

General Description

Antenna Circuit

Two RF ports are designed in this transceiver; internal antenna and external antenna. An RF switch controls which antenna path is going to be used during operation. Since this transceiver operates in two frequency bands(800MHz and 1900MHz), the switch also controls the RF frequency paths. Only one RF port and frequency band is used at a time, therefore, only one RF switch configuration is used while the other is irrevelent.

RX Front End

In 800MHz mode, the receive signal is mixed with the VCO and the result is the IF signal which is filtered prior to entering the Custom IC.
In 1900MHz mode, the receive signal is goes through a frequency doubler before getting mixed with the 1900MHz receive signal. This process allows the 1900MHz carrier frequency to be removed without the need of a second VCO.

NADC IC

The NADC/PDC ZIF/SYN is a 2.75 volt 81 pin BGA. It provides two fractional N phase locked loops for use with external VCOs. The transmit loop operates at 157.32 MHz in the cellular band and 192.36 MHz in the PCS band. The RX loop operates from 981-1006 MHz in the cellular band and from 1021-1051 MHz in the PSC band. The IC also provides regulator and superfilter functions for its synthesizer and the external VCOs. The IF portion of the IC operates with an input frequency of 112.32 MHz. The IC is linear up to the I and Q outputs of the baseband filters, can operate with internal or external AGC, and has a minimum dynamic range of -96.5 to -5.5 dBm. Both ZIF and SYN sections of the IC contain battery saving circuitry controlled by the SPI, and activated by an external pin.

TX Operational Description

For the 800 Mhz band, the TX carrier frequency is generated by mixing the main VCO signal with the offset VCO.In analog mode, the Offset VCO is modulated to provide FM. In digital mode, the mixer output feeds an IQ modulator which is bypassed in analog mode.The signal passes through attenuators before being fed to the driver amplifier with bandpass filters and then it is sent to the 2 stage power amplifier. The Offset VCO, TX mixer, IQ modulator and amplifiers are contained within a custom integrated circuit.

The MerlinTX is a custom IC intended to provide IQ modulator, power control, and exciter functions for IS-136 TDMA portable cellular phones. Both cellular and PCS bands are supported. The IC is packaged in a 5X5 mm, 0.5 mm pitch 32 pin BCC++ package. The following functional blocks are contained in the IC:

- Feedback amplifier for offset synthesis
- Offset mixer for transmit generation
- Quadrature Modulator
- VCA for transmit power control
- Cellular PA and PCS PA
- Upconverter for PCS operation

For the 1900 Mhz band, the signal from the Offset VCO mixes with the main VCO to provide the IF.The signal,after passing through a series of attenuators, is filtered and mixed with the Main VCO signal to generate the 1900 TX carrier frequency.This signal goes throught the amplifying stages.The synthesizer consists of a custom IC that contains a reference divider, phase detector circuitry,prescaler,regulators and a charge pump as well as some circuitry for the Offset VCO phase locked loop.

The reference frequency source for the Main VCO is provided by a temperature controlled crystal oscillator. In analog mode, DTMF, ST and SAT (among other things) are used to modulate the Offset VCO.In both 800 MHz and 1900 MHz digital modes, audio coming in from the microphoneis filtered, digitized and structured into a TDMA time slot. A directional coupler and detector circuit at the output of the power amplifier provides a carrier power indicator to the logic unit, which then uses this value as feedback to set the voltageto the voltage controlled attenuator in an automatic power control loop.Power output is continually monitored.

The transmitter and receiver are duplexed with bandpass filters to a switch that feeds the signal to either the antenna connector or the external antenna jack.

Power Amp Integrated 800 MHz or 1900 MHz IC

Both of the PA ICs used for 800 MHz and 1900 MHz are Dual monolithic GaAs HFET transistors with active bias control in a TSSOP 16 pin package with a slug.

Analog TX Audio Processing

The analog voice signal coming in through the microphone is taken by the CODEC and digitized.The samples produced by this step are then sent to the DSP.The following steps are realized with software implementation:

- Nominal TX Mic. Audio adjust amplifier
- Compressor -using a variable gain amplifier that controls the stage's gain by detecting the power at its output and applying the result to control the gain
- Deviation Limiter – using an amplifier in conjunction with a 7^{th} order odd polynomial with two output comparators. The polynomial reduces the amount of spectral splatter while the comparators switch as the signal reaches a high or low threshold.
- Audio mute
- Summing of all analog transmit modulation signals (Mic. Audio, Data/ST, DTMF and SAT)

A post-limiter splatter filter works with an up-shelf and a down-shelf filter to limit the maximum deviation of the transmitter.Data/ Signaling Tone is generated as a sinusoidal signal using a look-up table, which eases the filtering requirements for this signal because of the reduced harmonic energy it entails. DTMF is generated using look-up tables and SAT processing is also performed in the Transmit Audio Circuitry.

The D/A converts audio samples to an analog signal. This signal is then filtered and applied to the Analog Mod. Input of the synthesizer circuit

Digital TX Audio Processing

The analog voice signal coming in through the microphone is taken by the CODEC and digitized. The samples are transmitted to the DSP where microphone compensation and echo cancellation processes take place. The DSP uses ACELP to compress the samples into data bits.These bits are interleaved with speech data from adjacent speech frames for error protection. System messages are then combined with the data bits and sent to the data converter for modulation. The data converter modulates the data using differential quadrature phase shift keying (DQPSK). The bit streams generated from this step are converted to analog signals which are filtered before being transmitted.

DSP Lucent 1629

Digital Signal Processor, 80 MIPS, 3 volt operation. It has a DPS1600 core with 16k words of internal dual-port RAM and 48k words of ROM. It is contained in a 169 ball µBGA package with the balls on a 13 x 13mm grid on 0.8mm centers.

Stuart IC

The STUART chip is a device intended for the following five functions.

- The HPI module provides a bus interconnection function, the host port, for the call processor (HC12) to talk to the DSP section via the call processor's parallel bus, interconnected to the DSP's parallel memory bus.
- The DSP Timer module provides a timer function controlled from DSP.
- The IO, test, 19.44MHz clock control, SPI, and CS switch module provides a 4-bits general-purpose I/O port, with programmable data direction, chip testing output pins muxed with IO pins, 19.44MHz clock control, SPI bus enable control, and special RAM chip select switch function. It also is used to generate a PWM output (PWM_OSC pin).
- The GP timer module is a general purpose timer. It is synchronous, 16 bits, count-down, preloadable, readable, and reloading on terminal count. It's input clock is 32.768KHz, which can be disabled, divided-by-2, or divided-by-4.
- The FIFO SOI Interface provides a 96 bit and a 16 bit buffer register accessible by either the DSP or HC12. The DSP controls who has write access to the data buffer and the SPI control register. Data is written in using 8 bit words and sent via the RF SPI as either a 96 bit or 16 bit write. The SPI clock speed is selectable as either 4.86MHz or 1.215MHz. The external SPI clock automatically stops after each write. The internal SPI clock can be disabled to save current. A maskable interrupts are available at the end of each SPI write.

GCAP II

GCAP II is intended to provide audio and power management functions for Motorola cellular telephone applications. GCAP II is composed of two die. The GCAP II contains the following functions:

- 2.775V linear regulator (V1)
- 5V linear regulator (VSIM)
- 2.775V linear regulator (V2)
- 2.775V linear regulator (V3)
- 2.775V low current reference (REF)
- Two BUCK/BOOST switching regulators
  - Switcher # 1 not used
  - Switcher # 2 BUCK mode 3.3V
- The analog portions of a Real Time Clock
- Charge Pump Output
- High End PA Regulator
- Differential Speaker (earpiece) amplifier
- Single ended Alert amplifier
- Single ended Auxiliary amplifier
- SIM Card Level shifters (Not used)
- Turn on control signals to activate the radio
- Turn off control signals to turn off the radio if an error is detected
- Auxiliary battery controller
- Battery Charger
- SPI interface
- 10 channel 8 bit A/D
- 8 bit D/A
- Microphone amplifiers
- DSC bus buffers
- Audio CODEC with serial interface
- SPI interface
- Digital portions of the Real Time Clock

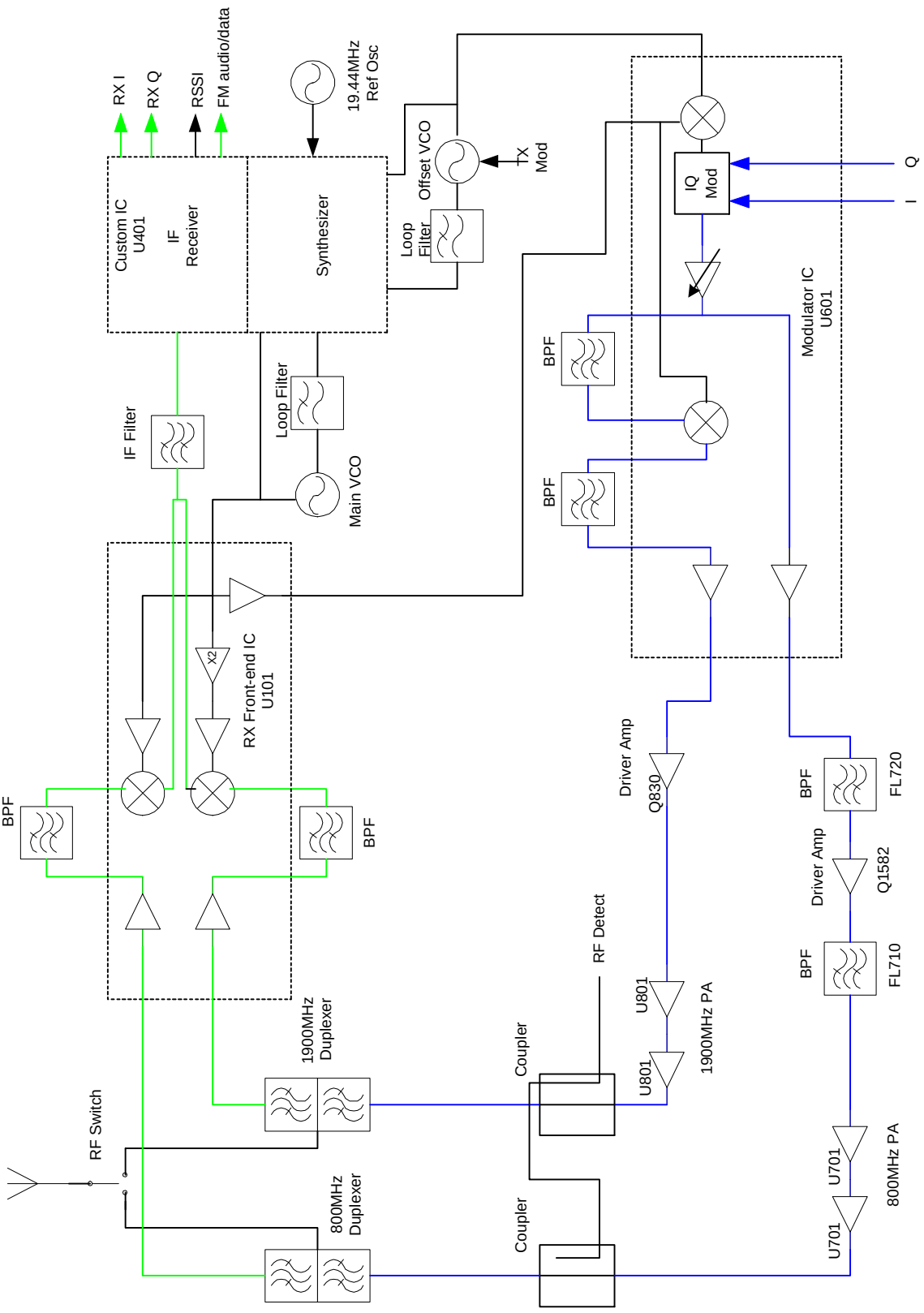


Figure 40. RF Block Diagram

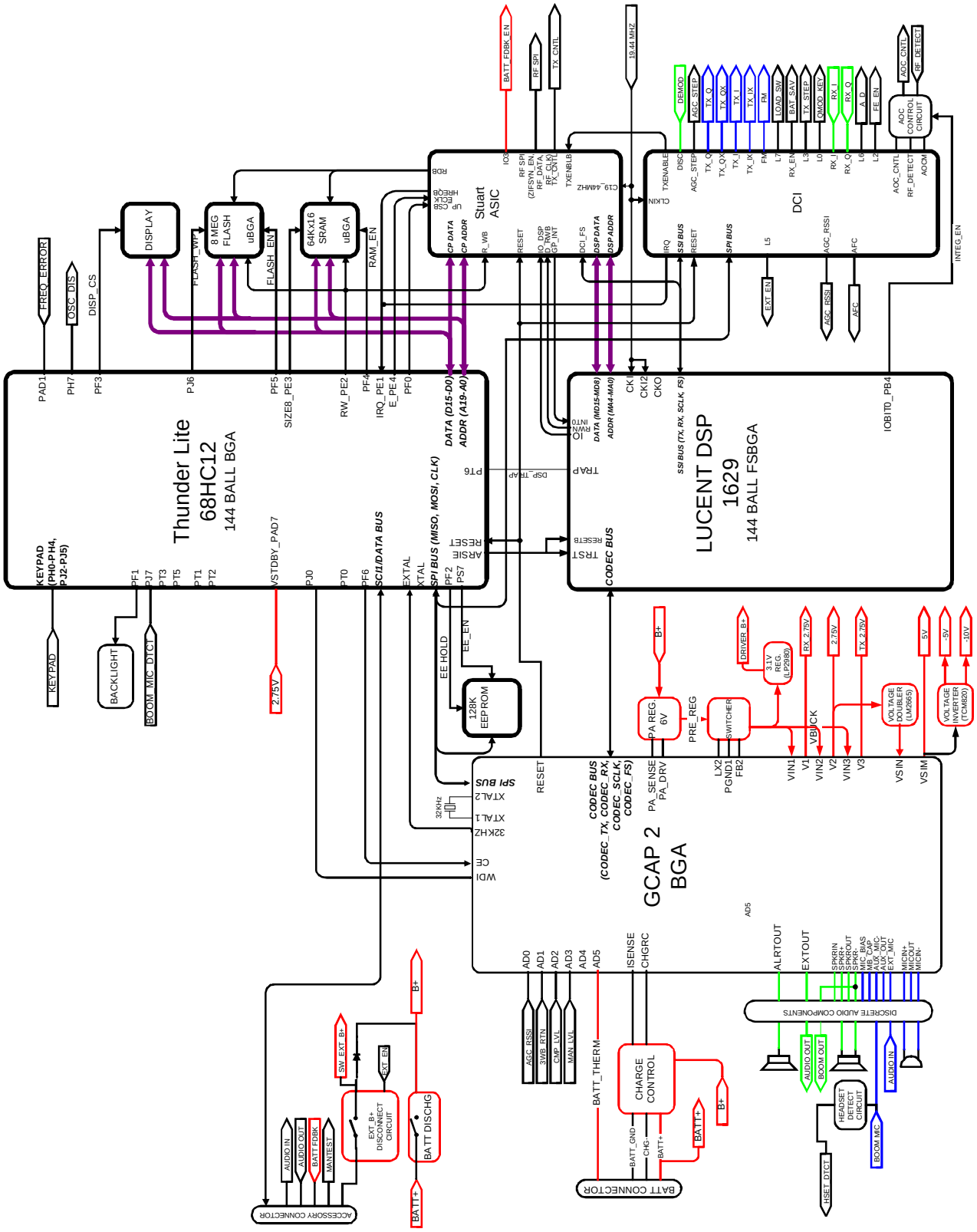


Figure 41. AL Block Diagram

Reference Designator	Part Number
A940	39-03918K01
C1000	21-13743M24
C1001	21-13741F49
C1002	21-13743E20
C1003	21-13743E20
C1004	21-13743M24
C1005	21-13743E20
C1006	21-13743M24
C101	21-13743N40
C102	21-13743N28
C104	21-13743N28
C105	21-13743N15
C106	21-13743N12
C107	21-13743L17
C108	21-13743N34
C109	21-13928A01
C110	21-13743L17
C111	21-13743N14
C112	21-13743N40
C113	21-13743N26
C114	21-13743L17
C115	21-13743N38
C116	21-13743N08
C117	21-13743N05
C118	21-13743N05
C119	21-13743N14
C120	21-13743N40
C1200	21-13928P04
C1201	21-13743M24
C1202	21-13743M24
C1203	21-13743M24
C124	21-13743L17
C1250	21-13928P04
C1251	21-13743M24
C126	21-13743L17
C127	21-13743N26
C130	21-13743L41
C1300	21-13743L41
C131	21-13743N69
C139	21-13743L17
C140	21-13743N20
C1400	21-13743N26
C1401	21-13743N26
C1402	21-13743N26
C1403	21-13743N26
C1404	21-13743N26
C1405	21-13743N26

Reference Designator	Part Number
C1406	21-13743N26
C1407	21-13743N26
C1408	21-13743N26
C1409	21-13743N26
C141	21-13743N69
C1410	21-13743N40
C1411	21-13743N40
C1412	21-13743N40
C1413	21-13743N40
C1414	21-13743N40
C1415	21-13743N26
C142	21-13743N22
C1420	21-13743F16
C1421	21-13743F16
C1422	21-13743F16
C1423	21-13743F16
C143	21-13743L17
C145	21-13743N12
C147	21-13743N18
C149	21-13743N03
C150	21-13743L41
C1500	21-13743E20
C1502	21-13743N18
C1503	21-13743N18
C1504	23-11049D06
C1505	23-11049A62
C1506	23-11049A59
C1507	21-13743E20
C1508	21-13928K09
C1509	21-13928P04
C151	21-13743N40
C1510	21-13743N40
C1511	21-13743N40
C1512	21-13743N40
C1513	21-13743N40
C1514	21-13743N40
C1515	21-13743N40
C1516	21-13743N40
C1517	21-13743E20
C1518	23-09121D09
C1519	23-09121D09
C152	21-13743N35
C1520	21-13743M24
C1521	21-13743N40
C1522	21-13743N40
C1523	21-13743N40
C1524	21-13743N40

Reference Designator	Part Number
C153	21-13743N37
C1530	23-11049A59
C1531	23-11049A59
C1532	21-13743N40
C1533	21-13928N01
C1534	21-13743B29
C1535	21-13743N40
C1536	21-13743N40
C1540	21-13743N40
C1541	21-13928N01
C1542	21-13743E20
C1543	21-13928N01
C1544	21-13743N40
C1549	21-13743N40
C1550	21-13743E20
C1551	21-13743N40
C1552	21-13743N40
C1553	21-13741F25
C1554	21-13743N24
C1555	21-13743N24
C1556	21-13743M24
C1558	21-13743E20
C1559	21-13743N40
C1560	21-13743N40
C1561	21-13743L01
C1562	21-13743L01
C1563	23-11049A89
C1564	21-13928N01
C1565	21-13743N50
C1567	21-13743N40
C1569	21-13743N40
C157	21-13743N12
C1570	21-13743E20
C1571	21-13928L05
C1572	21-13928L05
C1573	21-13743L41
C1574	23-11049A54
C1575	23-11049A54
C1576	23-11049A54
C158	21-13743N26
C1583	21-13743N40
C1584	21-13743N40
C1585	21-13743N40
C1586	21-13743E20
C1587	21-13743E20
C1588	23-11049A62
C1589	21-13743L17

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Reference Designator	Part Number
C159	21-13743N40
C1590	21-13743N40
C1591	21-13743L05
C1592	21-13743N40
C1593	21-13743N40
C1594	21-13743N40
C1595	21-13743L09
C160	21-13743N50
C1702	21-13743M24
C177	21-13743N40
C1900	21-13743G26
C1901	21-13743N40
C1902	21-13743M24
C1903	21-13743M24
C1904	21-13743M24
C1905	21-13743M24
C1906	21-13743M24
C1907	21-13743G26
C1908	21-13743N50
C1914	21-13928P04
C1915	21-13743M24
C1916	21-13743M24
C1917	21-13743N50
C1918	21-13741F49
C201	21-13743N50
C202	21-13743E20
C203	21-13743E07
C204	21-13743L25
C205	21-13743L41
C206	21-13743L41
C207	21-13743L41
C260	21-13743L17
C261	21-13743N40
C301	21-13740B88
C302	21-13741F19
C303	21-13743L07
C305	21-13743N40
C306	21-13743L41
C307	21-13743N40
C310	21-13743L17
C311	21-13741F49
C312	21-13743A19
C401	21-13743A23
C402	21-13743E20
C403	21-13743L17
C404	21-13743L17
C405	21-13743L17

Reference Designator	Part Number
C406	21-13743E20
C407	21-13743L41
C408	21-13743E20
C409	21-13743E20
C410	21-13743E20
C411	21-13743A23
C412	21-13741F39
C413	21-13743N26
C414	21-13743N50
C415	21-13743L41
C416	21-13743L41
C417	21-13743L41
C418	21-13743L17
C420	21-13743L41
C421	21-13743F16
C422	21-13743L41
C423	21-13743F16
C424	21-13743L41
C425	21-13928C03
C426	21-13743L41
C427	21-13743N40
C430	21-13743N40
C431	21-13743L17
C432	21-13743L41
C433	21-13743L05
C434	21-13743L41
C435	21-13743N24
C436	21-13743N16
C450	21-13741A59
C451	21-13743L11
C452	21-13743L05
C453	21-13743E07
C454	21-13743N30
C455	21-13743N30
C456	21-13743L01
C457	21-13743L01
C462	21-13743N40
C50	21-13743N40
C501	21-13743L27
C502	21-13743N18
C503	21-13743N32
C504	21-13743N28
C505	21-13743L17
C506	21-13743N52
C507	21-13743L01
C508	21-13743L01
C509	21-13743L27

Reference Designator	Part Number
C510	21-13743N09
C511	21-13743N52
C512	21-13743L17
C513	21-13743E20
C514	21-13743L17
C515	21-13741A61
C516	23-11049A40
C517	21-13743L17
C602	21-13743N40
C603	21-13743L41
C604	21-13743N40
C605	21-13743N40
C606	21-13743L17
C607	21-13743N26
C608	21-13743N28
C609	21-13743N28
C610	21-13743L41
C620	21-13743N40
C621	21-13743L41
C622	21-13743N24
C623	21-13743N40
C624	21-13743L41
C625	21-13743N24
C626	21-13743N40
C627	21-13743L17
C629	21-13743N40
C652	21-13743N40
C653	21-13743L17
C666	21-13743L17
C701	21-13743N69
C703	21-13743M24
C704	21-13743N40
C705	21-13743N40
C706	21-13743N40
C707	21-13743N26
C709	21-13743N40
C710	21-13743N24
C711	21-13743N40
C712	21-13743N40
C715	21-13928N01
C716	21-13743N40
C717	21-13743N40
C719	21-13743N67
C720	21-13743N40
C721	21-13743N24
C722	21-13743N24
C726	21-13743N11

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Reference Designator	Part Number
C727	21-13743N24
C729	21-13743N40
C730	21-13743N40
C731	21-13743N14
C740	21-13743N40
C741	21-13743N15
C744	21-13743N15
C758	21-13743E20
C771	21-13743N28
C777	21-13743N40
C778	21-13743N28
C801	21-13743N24
C804	21-13743N24
C805	21-13743N09
C806	21-13743N10
C807	21-13743N69
C808	21-13743N09
C809	21-13743N24
C811	21-13743N09
C812	21-13743N03
C813	21-13743N28
C816	21-13743N09
C817	21-13743N03
C820	23-03770S12
C829	21-13743N24
C830	21-13743N28
C831	21-13743N05
C833	21-13928N01
C834	21-13743N24
C835	21-13743N05
C836	21-13743N28
C840	21-13743N28
C841	21-13743N24
C888	21-13743N28
C901	21-13743N28
C902	21-13743N28
C903	21-13743N09
C904	21-13743L41
C905	21-13743L41
C906	21-13743N40
C907	21-13743N28
C908	21-13743L41
C909	21-13743N28
C910	21-13743N16
C911	21-13743N28
C912	21-13743N40
C994	21-13743L41

Reference Designator	Part Number
C995	21-13743N24
C998	21-13743N07
C999	21-13743N09
CR1000	48-09606E07
CR1001	48-09606E07
CR1300	48-13833N13
CR1301	48-13833N13
CR1420	48-09924D06
CR1500	48-09606E02
CR1506	48-09653F02
CR1540	48-09606E02
CR1560	48-09606E08
CR1561	48-09606E02
CR456	48-09877C08
CR501	48-09948D13
CR502	48-09877C08
CR503	48-09877C08
CR666	48-09606E02
CR701	48-09007R01
CR723	48-09606E02
CR730	48-09948D12
CR901	48-09948D33
CR902	48-09948D12
CR903	48-09948D33
CR904	48-09948D33
DS1400	48-09496B04
DS1401	48-09496B04
DS1402	48-09496B04
DS1403	48-09496B04
DS1404	48-09496B04
DS1405	48-09496B04
DS1406	48-09496B04
DS1407	48-09496B04
DS1408	48-09496B04
DS1409	48-09496B04
DS1410	48-09496B04
DS1411	48-09496B04
FL108	91-03913K04
FL120	91-85861J02
FL140	91-03917K02
FL601	91-85623G02
FL620	91-03913K06
FL710	91-03913K03
FL720	91-03913K03
FL930	91-85911J05
FL931	91-85911J02
J1	09-09350J03

Reference Designator	Part Number
J2	09-09449B06
J7	09-09059E01
J8	09-09399T01
J950	09-09409S01
JMIC	09-09195E01
L101	24-09154M61
L110	24-09154M62
L111	24-09154M58
L112	24-09154M55
L135	24-09154M54
L140	24-09704K51
L141	24-09704K49
L142	24-09704K52
L144	24-09154M12
L150	24-62587Q53
L1500	25-87928K13
L1550	24-09154M70
L1551	24-09154M70
L1552	24-09646M80
L435	24-04574Z11
L456	24-09414M09
L501	24-09414M17
L502	24-62587V29
L601	24-09154M70
L602	24-09414M17
L607	24-09154M65
L620	24-09154M61
L621	24-09154M63
L651	24-09154M70
L701	24-09348J08
L702	24-09154M57
L710	06-62057M01
L711	24-09646M98
L712	06-62057M01
L730	24-09646M22
L740	24-09154M63
L741	24-09154M63
L783	24-09646M97
L830	24-09154M58
L831	24-09646M98
L832	24-09154M51
L901	24-09154M55
L902	24-09154M60
L903	24-09154M60
L999	24-09154M59
Q104	48-09939C06
Q105	48-09939C06

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Reference Designator	Part Number
Q1100	48-09579E29
Q1102	48-09939C02
Q1200	48-09605E02
Q1201	48-09579E36
Q1300	48-09579E29
Q1301	48-09807C32
Q1302	48-09579E29
Q1303	48-09579E39
Q1304	48-09939C25
Q1400	48-13824M28
Q1401	48-09605E05
Q151	48-09579E24
Q152	48-09605E02
Q1560	48-09940E02
Q1570	48-13823A16
Q1571	48-13823A15
Q201	48-09579E02
Q212	48-09579E02
Q230	48-09579E02
Q231	48-09579E02
Q260	48-09607E05
Q261	48-09579E02
Q270	48-09607E05
Q301	48-09579E30
Q502	48-09527E24
Q503	48-09579E02
Q551	48-09579E43
Q666	48-09607E05
Q667	48-09605E02
Q668	48-09579E42
Q711	48-09579E42
Q715	48-09527E22
Q721	48-09579E29
Q723	48-09579E24
Q820	48-09807C32
Q830	48-87716K01
Q901	48-09607E05
Q902	48-09579E30
Q904	48-09527E18
R1001	06-09591M25
R1002	06-62057M84
R1003	06-62057N15
R1008	06-62057N03
R1009	06-62057M98
R1010	06-62057M98
R1011	06-62057N03
R1012	06-62057M26

Reference Designator	Part Number
R1013	06-62057M98
R1014	06-62057N03
R1015	06-62057N23
R1030	06-62057N09
R1031	06-62057N15
R1032	06-62057N15
R1100	06-62057N09
R1101	06-62057V03
R1102	06-62057M98
R1103	06-62057M98
R1105	06-62057M98
R1106	06-62057M98
R114	06-62057M19
R1200	06-62057M90
R1201	06-62057M98
R1202	06-62057N15
R1203	06-62057M98
R1204	06-62057N23
R1205	06-62057M74
R128	06-62057M19
R1300	06-09175L03
R1302	06-62057M92
R1303	06-62057N23
R1304	06-62057N23
R1305	06-62057M98
R1306	06-62057M90
R1402	06-09591M25
R1403	06-09591M25
R1404	06-09591M25
R1405	06-62057M74
R1406	06-11079A20
R1410	06-09591M25
R1411	06-09591M25
R1412	06-09591M25
R1413	06-09591M25
R1414	06-09591M25
R1415	06-09591M25
R1416	06-09591M25
R1417	06-09591M25
R1418	06-09591M13
R1419	06-09591M13
R1420	06-09591M13
R1421	06-09591M13
R1422	06-09591M13
R1423	06-09591M13
R1504	06-09591M37
R1505	06-62057M01

Reference Designator	Part Number
R151	06-62057N03
R1511	06-62057V11
R1512	06-62057V21
R1514	06-62057V25
R1515	06-62057V14
R152	06-62057N15
R1520	06-62057M50
R153	06-62057N09
R1530	06-62057N17
R1531	06-62057N09
R1532	06-62057M74
R1533	06-62057M66
R1534	06-62057M58
R154	06-62057M67
R155	06-62057M01
R1550	06-62057M98
R1551	06-62057N15
R1552	06-62057M71
R1553	06-62057M71
R1554	06-11079A09
R1555	06-11079A09
R1560	06-62057N15
R1561	06-62057M54
R1562	06-62057M90
R1563	06-62057M98
R1564	06-62057N31
R157	06-62057M64
R1572	06-62057N23
R1582	06-62057M82
R1583	06-62057M82
R1584	06-62057M98
R1585	06-62057M98
R1586	06-62057N31
R1587	06-62057N23
R1588	06-62057N23
R159	06-62057N01
R1900	06-62057M26
R1901	06-62057M90
R1902	06-62057N15
R1903	06-62057V15
R1904	06-62057N15
R1905	06-62057N33
R1906	06-62057M82
R1914	06-62057M01
R1915	06-62057N13
R1923	06-62057M01
R201	06-62057N23

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Reference Designator	Part Number
R202	06-62057M98
R204	06-62057N17
R205	06-62057N17
R206	06-62057N16
R207	06-62057M01
R208	06-62057N11
R209	06-62057M82
R212	06-62057N15
R255	06-62057N33
R301	06-62057M92
R302	06-62057N07
R303	06-62057M94
R304	06-62057M50
R307	06-62057M01
R310	06-62057M90
R323	06-62057M01
R352	06-62057M43
R353	06-62057M43
R414	06-62057M74
R452	06-62057M90
R453	06-62057M98
R501	06-62057M96
R503	06-62057M64
R504	06-62057M81
R505	06-62057N15
R506	06-62057N06
R507	06-62057N01
R508	06-62057N17
R509	06-62057M72
R510	06-62057M54
R511	06-62057N03
R512	06-62057M68
R601	06-62057M78
R603	06-62057M43
R621	06-62057N13
R622	06-62057N13
R623	06-62057N07
R667	06-62057M86
R668	06-62057M98
R669	06-62057M90
R670	06-62057M98
R671	06-62057M98
R673	06-62057U78
R674	06-62057M71
R675	06-62057M71
R676	06-62057U78
R677	06-62057M01

Reference Designator	Part Number
R681	06-62057M74
R682	06-62057M74
R701	06-62057M96
R703	06-62057M83
R710	06-62057M26
R711	06-62057M61
R712	06-62057M98
R713	06-62057M38
R714	06-62057M85
R715	06-62057M43
R716	06-62057M50
R720	06-62057M98
R723	06-62057M74
R724	06-62057N07
R730	06-62057M61
R740	06-62057M36
R741	06-62057M36
R747	06-62057M26
R801	06-62057M84
R802	06-62057M84
R820	06-62057M98
R830	06-62057M28
R831	06-62057M66
R832	06-62057M98
R833	06-62057M34
R834	06-62057M82
R835	06-62057M26
R839	06-62057M66
R841	06-62057M66
R901	06-62057M50
R902	06-62057M90
R903	06-62057M62
R904	06-62057M76
R905	06-62057M38
R906	06-62057M58
R907	06-62057M90
R908	06-62057M90
R909	06-62057N11
R920	06-62057M46
SH4	26-03817S01
SH430	26-85782H02
SH431	26-87355K01
SH432	26-87354K01
SH433	26-87353K01
SH434	26-87352K01
SH435	26-87351K01
SH436	26-87350K01

Reference Designator	Part Number
SH437	26-85996K01
SH5	26-03821S01
U1000	51-09841C53
U101	51-09944C39
U104	51-09923D49
U1100	51-09817F17
U1200	51-99404A01
U1201	51-99434A01
U1250	51-09509A16
U1420	51-09920D22
U150	48-09443R06
U1500	51-09879E42
U1560	51-09817F27
U1590	51-09512F35
U1900	51-99400C02
U1903	51-09962C16
U201	51-09817F34
U301	48-09283D38
U401	51-09879E24
U601	51-09879E25
U701	51-09730C16
U704	51-09572E19
U801	51-09730C15
VR1100	48-13830M25
VR1550	48-09788E06
VR1551	48-09788E06
VR1552	48-09788E06
VR1553	48-09788E06
XFMR601	58-85758J03
Y1500	48-09995L08

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Service Diagrams

Introduction

The service diagrams were carefully prepared to allow a Motorola certified technician to easily troubleshoot cellular phone failures. Our professional staff provided directional labels, color coded traces, measurement values and other guidelines to help a technician troubleshoot a cellular phone with speed and accuracy.

We worked hard in trying to provide the best service diagrams, therefore, to avoid cluttered diagrams, we excluded some components from the service diagrams. Our professional staff carefully selected to excluded components that are unlikely to fail.

Test Point Measurements

The measurements labeled on the service diagrams are approximate values and may vary slightly. These measurements are dependent on the accuracy of the test equipment.

It is strongly recommended that the test equipment calibration schedule be followed as stated by the manufacturer. RF probes should be calibrated for each frequency in which tests are going to be performed.

The types of probes used will also affect measurement values. Test probes and cables should be tested for RF losses and loose connections.

Because of the sensitivity of RF, measured readings will be greatly affected if they're taken in certain locations. To get the most accurate readings, take measurements nearest to the labeled measurement on the service diagram.

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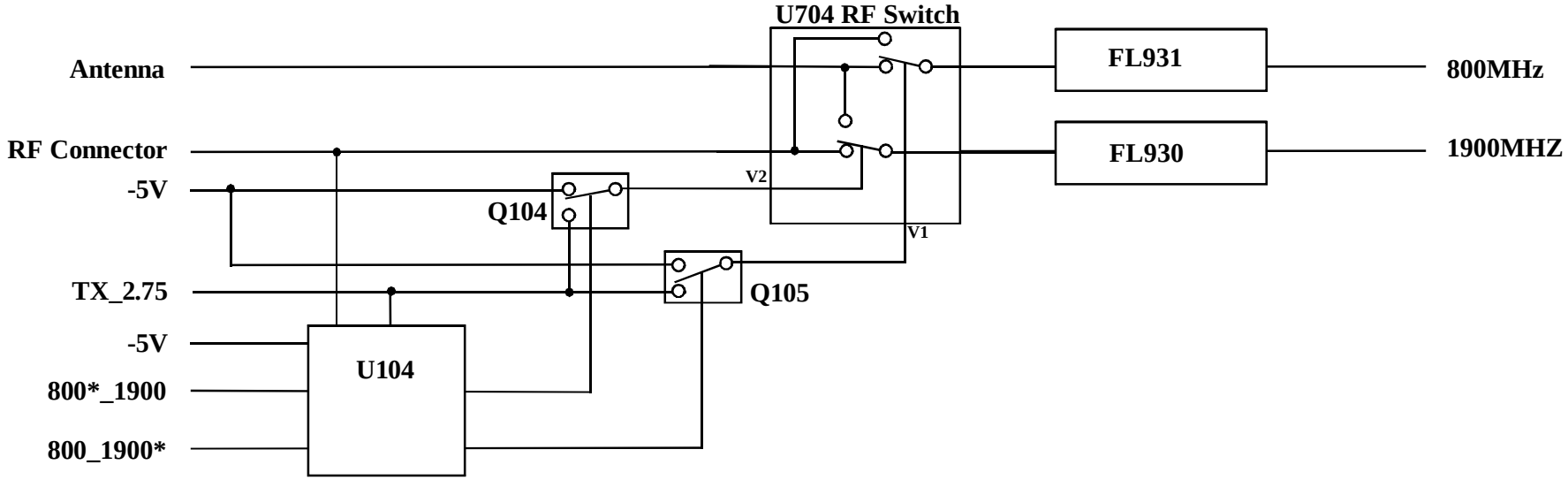
TDMA M3090/M3097: Antenna Circuit



B2

Description

Two RF ports are designed in this transceiver; internal antenna port and RF connector port. The RF switch (U704) controls which antenna path is going to be used during operation. Since this transceiver operates in two frequency bands (800MHz and 1900MHz), U704 also controls the RF frequency paths. U704 has two control inputs which are used to control the RF port that will be used and frequency band routing.

The antenna will be used only when there is no 50 Ω load detected by U104 at the RF Connector port.

The output of U104 is determined by the input states of 800*_1900 line, 800_1900* line and the RF Connector load detect line. Refer to the Band Select and Antenna Select chart on page B3 for a detailed description on how the different input states affect the outputs of both U104 and U704.

800*_1900 and 800_1900* determines the desired frequency band. A high (2.75V) state at 800*_1900 designates 800MHz mode while a low (0V) state designates 1900MHz. The opposite holds true for 800_1900* .

Having a high state at V2 and a low state at V1 will configure U704 to route the antenna port to the 1900MHz RF path and the RF Connector port to the 800MHz RF path. A low state at V2 and a high state at V1 will configure U704 to route the antenna port to the 800MHz RF path and the RF Connector port to the 1900MHz RF path.

Only one RF port and frequency band is used at a time, therefore, only one RF switch configuration is used while the other is irrevelent.

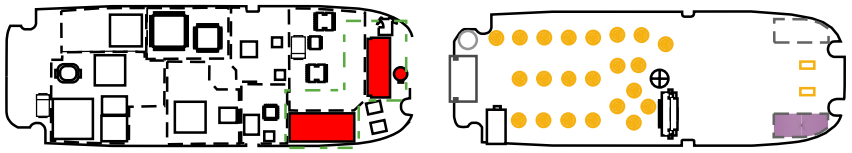
TDMA M3090/M3097: Antenna Circuit

Band / Antenna	800 Internal	800 External	1900 Internal	1900 External
D	2.72V	-4.6V	-4.65V	2.69V
E	-4.65V	2.69V	2.72V	-4.3V
F	2.2V	-4.15V	-4.16V	2.18V
G	-4.15V	2.19V	2.21V	-4.1V

Channel: 333
Cellular TX Freq: 834.99MHz
PCS TX Freq: 1859.97MHz
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm

TX SIGNAL
RX SIGNAL
VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.



RX:-21.4 dBm@Cellular
TX: 25.2 dBm

RX:-20 dBm@PCS
TX:+26 dBm

RX:-20 dBm@Cellular
TX: 26.4 dBm

-4.78V
-5V page B29
2.75V
TX_2.75 page B27
U1903-64 page B41
800*_1900
U1903-63 page B41
800_1900*
-4.78V
-5V page B29
2.75V
TX_2.75 page B27

C102 C109 C994 C104 Q105 C462 U704 C777 C778 R1906 L999 C999 C998 A940 C721 C771 C720 Q104 U104 C995 FL930 J950

RX:-21 dBm@PCS
TX:+26 dBm

FL931

C741 page B19 TX_800
C112 page B5 RX_800
TX_1900 C888 page B17
RX_1900 C113 page B5

B3

Band	800	1900
A	2.73V	0V
B	0V	2.73V

Antenna	Internal	External
C	2.78V	.611V

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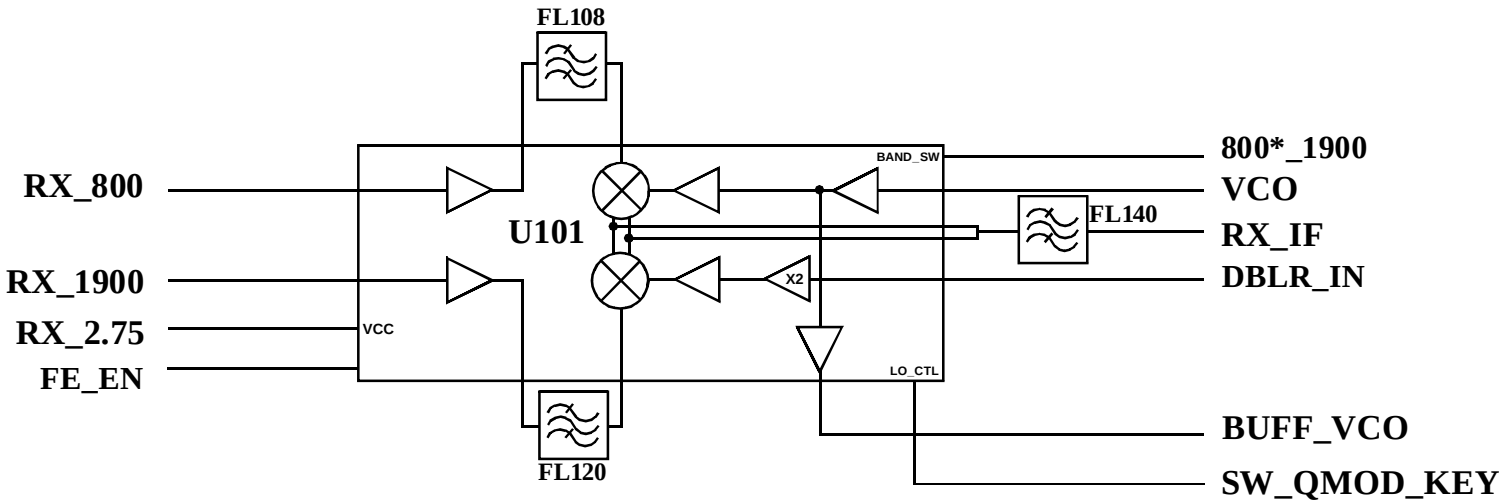
TDMA M3090/M3097: Down Converter



B4

Description

The RX front end IC(U101) is used as a first amplifier and downconverter for dual-band RF applications. It removes the RX carrier frequency to produce the RX IF signal. U101 also has some internal LNAs for the receive signals and buffers for the VCO signals.

U101 has two RF input ports. One is used for the 800MHz signal and the other is used for the 1900MHz signal. Both signals are amplified within U101 and then routed to an exter - nal filter(FL108, FL120). The signal is then injected into the Down Converter U101.

In 800MHz mode, the receive signal is mixed with the VCO and the result is the IF signal which is filtered by FL140 prior to enter ing the ZIF/ZYN IC(U401).

In 1900MHz mode, the VCO output (**DBLR_IN**) goes through a frequency doubler inside U101 before getting mixed with the 1900 MHz receive signal. This process allows the 1900MHz carrier frequency to be removed without the need of a second VCO.

In 800MHz mode, only the 800MHz side of U101 is enabled via the 800*_1900 line. Line 800*_1900 is high in 800MHz mode and low in 1900MHz mode.

Complete operation of U101 can also be disabled by the **FE_EN** line. A low state at **FE_EN** will disable U101. When the unit is in a sleep mode condition, the **BAT_SAV** line is pulled high. This state causes Q212 to switch on, thus, grounding the FE_EN line (refer to page B25).

TDMA M3090/M3097: Down Converter

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B5

R307 page B9 — VCO — -9.35 dBm@PCS 1026.165MHz — -9.27 dBm@Cellular 992.31MHz

C605 page B13 — BUFF_VCO — -30.47 dBm@Cellular 992.31MHz

RX_2.75V page B27 — 2.77V

-26.8 dBm 1940.01MHz

Channel: 333
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm
VCO SIGNAL
RX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

TX	On	Off
A	0V	2.72V

Band	800	1900
B	0V	2.73V

RX	On	Off
C	2.73V	0V

R352 R353 C50 C130 C139 L141 L140 R114 C124 C145 C120 C119 C142 C141 C149 L142 C143 C140 C118 C115 C117 R157 C114 L112 C157 C116 C113 C101 L111 C110 R159 C159 L110 C111 C112 L135 L144 C127 C177 C126 C131 L101 C107 C108 C105 C106 R218

FL120 In Out

FL140 4 1 In Out 3 2

FL108 6 1 5_Out 2_In 4 3

U101 1 VCC1 18 2.74V DBLR_OUT 6 VCC1 13 2.74V

-18.81 dBm 112.32MHz

-18.81 dBm 112.32MHz — RX_IF — L435 page B7 — 2.77V — RX_2.75V page B27

-13.82 dBm 879.99MHz

-11.62dBm 879.99MHz

-8.93 dBm 1940.01MHz — -26.49 dBm 1940.01MHz — RX_1900 — FL930 page B3

SW_QMOD_KEY (A) — Q270 page B19

(B) 800*_1900 — U1903-64 page B41

(C) FE_EN — U201-18 page B25

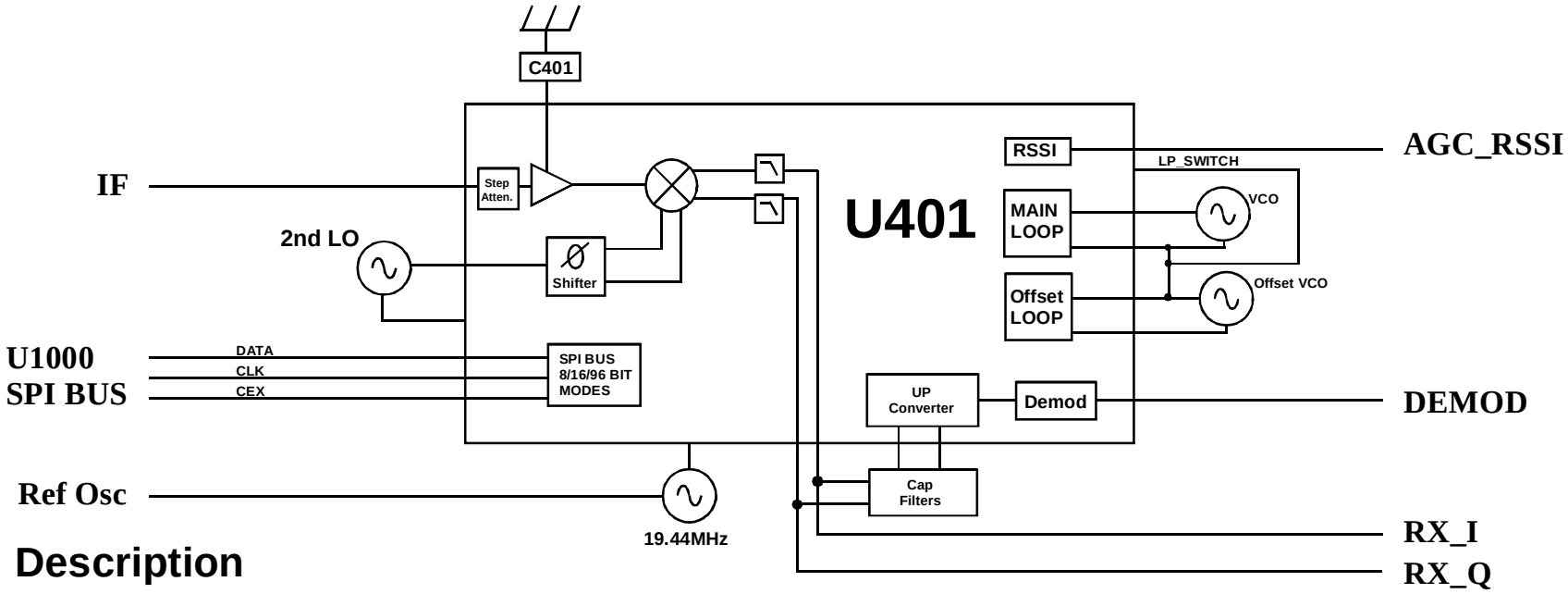
-27.15 dBm 879.99MHz — RX_800 — FL931 page B3

DBLR_IN — R155 page B9

-9.35 dBm@PCS 1026.165MHz

-9.27 dBm@Cellular 992.31MHz

TDMA M3090/M3097: ZIF_SYNTH (U401)



B6

Description

U401(ZIF_SYNTH) can be divided into two functional subsystems: The ZIF (Zero-Intermediate-Frequency) which provides all of the functions of the back-end of a receiver, and the SYN (SYNthesizer) which contains phase-locked loops and modulators to produce the Local Oscillator (LO) and modulated transmit carrier.

The ZIF implements the back end of the receiver. The incoming signal is attenuated, amplified and mixed down to an extremely low frequency(Baseband)-not quite DC. The first amplifier and an Automatic Gain Control(AGC) circuit adjusts the amplifier gain to maintain a constant level in the baseband filter. C401 is used to add stability to the AGC circuit.

The first mixing that occurs in the ZIF requires a 2nd Local Oscillator that is running at 221.184MHz. The 2nd LO is divided down then phased shifted before being mixed with the IF signal., producing the baseband signal

The baseband signal is low-pass filtered using a programmable low-pass filter. In TDMA mode, the baseband signal is routed to U201(DCI) via the RX_I and RX_Q lines. In analog mode, the baseband signal is up-converted and then FM-demodulated, producing the DEMOD signal which is routed to U201(DCI) for filtering and de-emphasis.

The RSSI(Receive Signal Strength Indicator) is a voltage that increases with respect to the received signal strength.

The SPI Bus is a serial interface used to program the internal filters and frequency dividers for U401, allowing selectivity of cellular channels.

RF 19.44Mhz input is used to provide a frequency reference for U401.

TDMA M3090/M3097: ZIF_SYNTH (U401)

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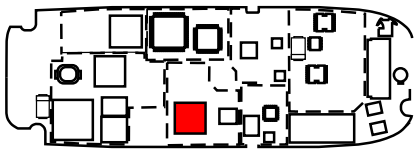
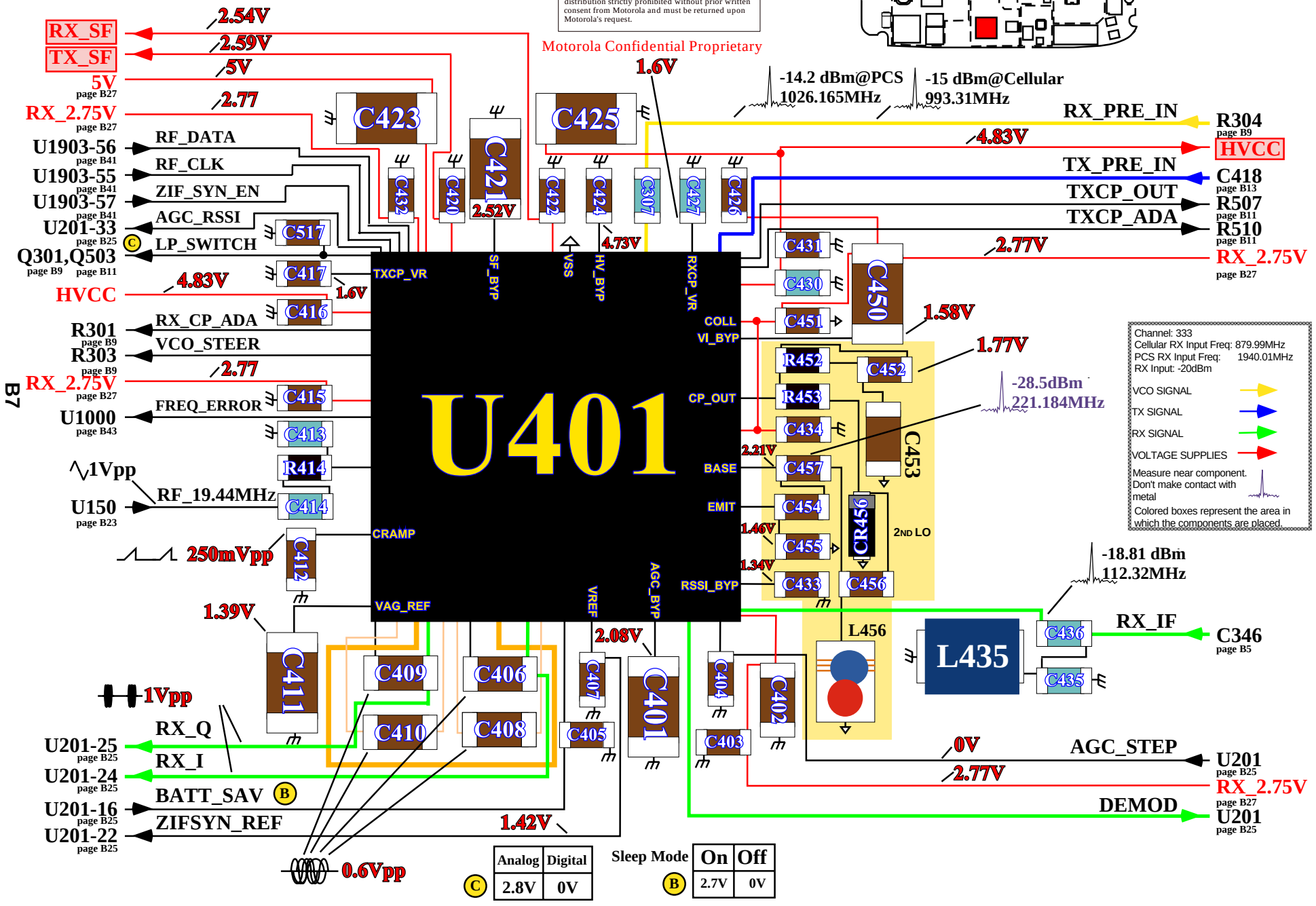
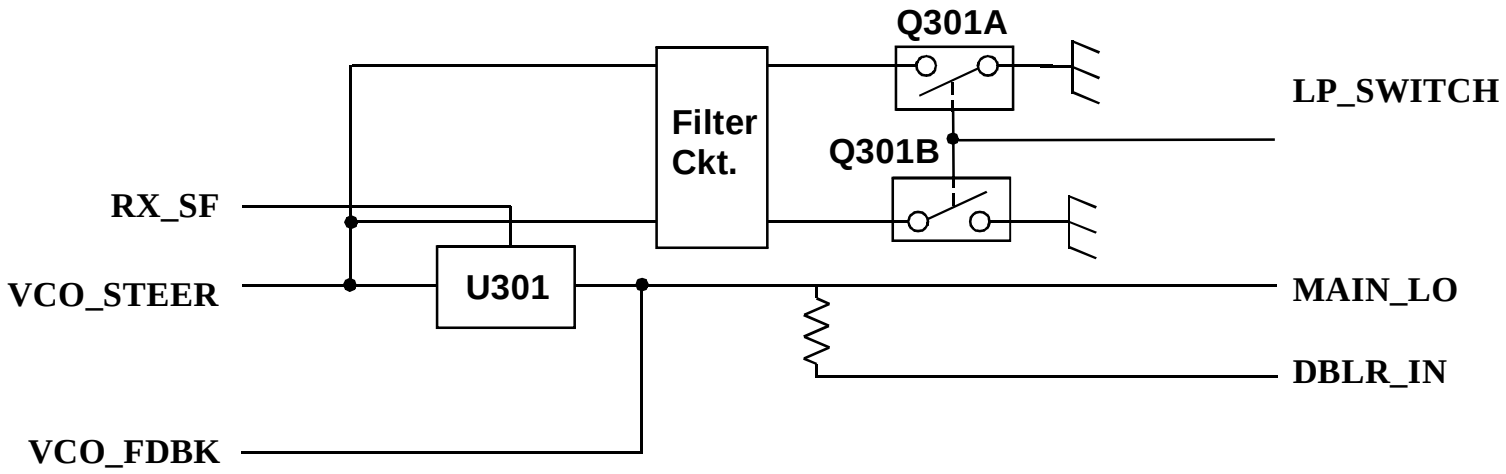




C	Analog	Digital
	2.8V	0V

Sleep Mode	On	Off
B	2.7V	0V

TDMA M3090/M3097: VCO



B8

Description

U301 is the local oscillator module used to add frequency selectivity to the transceiver. The frequency of oscillation is dependent on the channel and band that the transceiver will be operating in. The frequency is controlled by U401. U401 will receive channel information via the SPI bus and adjust the frequency of U301 by varying the voltage level to the input (**VCO_STEER**) of U301.

The output of U301 is split into three paths. One path (**VCO_FDBK**) is used to feed back the produced signal to U401. The signal is prescaled and sent through a phase lock loop circuit for frequency locking. The second path (**MAIN_LO**) is sent to the receive circuit for carrier signal removal. The third path (**DBLR_IN)** goes to the Down Mixer U101 for PCS down mixing. U101 uses the same **DBLR_IN** to provide a local osc. to the TX circuit (refer to B8).

When the transceiver is operating in the 800MHz band, U301 will oscillate at a frequency of 112.32+RX frequency. In the 1900MHz band, U301 will oscillate at a frequency of (112.32+RX)/2.

RX_SF (Super Filter) comes from U401 and provides a clean supply voltage to the VCO module.

LP_SWITCH control comes from U401. In Analog mode, the input to Q301 becomes high causing it to close so the filter ciruitry becomes active which in turn is used to improve phase noise due to stringent adjacent channels in Analog mode.

TDMA M3090/M3097: VCO

Channel: 333
PCS VCO Freq: 1026.165MHz
Cellular VCO Freq: 993.31MHz

VCO SIGNAL

VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

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B9

U401 page B7 — RXCP_ADA — 0V — R301

U401 page B7 — VCO_STEER — A — C301

C302 — R302 — C312 — R310 — C311 — Q301

0V — B — LP_SWITCH — U401 page B7

Channel	991	333	799
A	1.19V	1.54V	1.97V

	Analog	Digital
B	2.8V	0V

RX_SF page B7 — 2.54V — C306 — C305 — C303 — R303 — C310 — 0V

7 — 6 — 5

U301

8 — 4

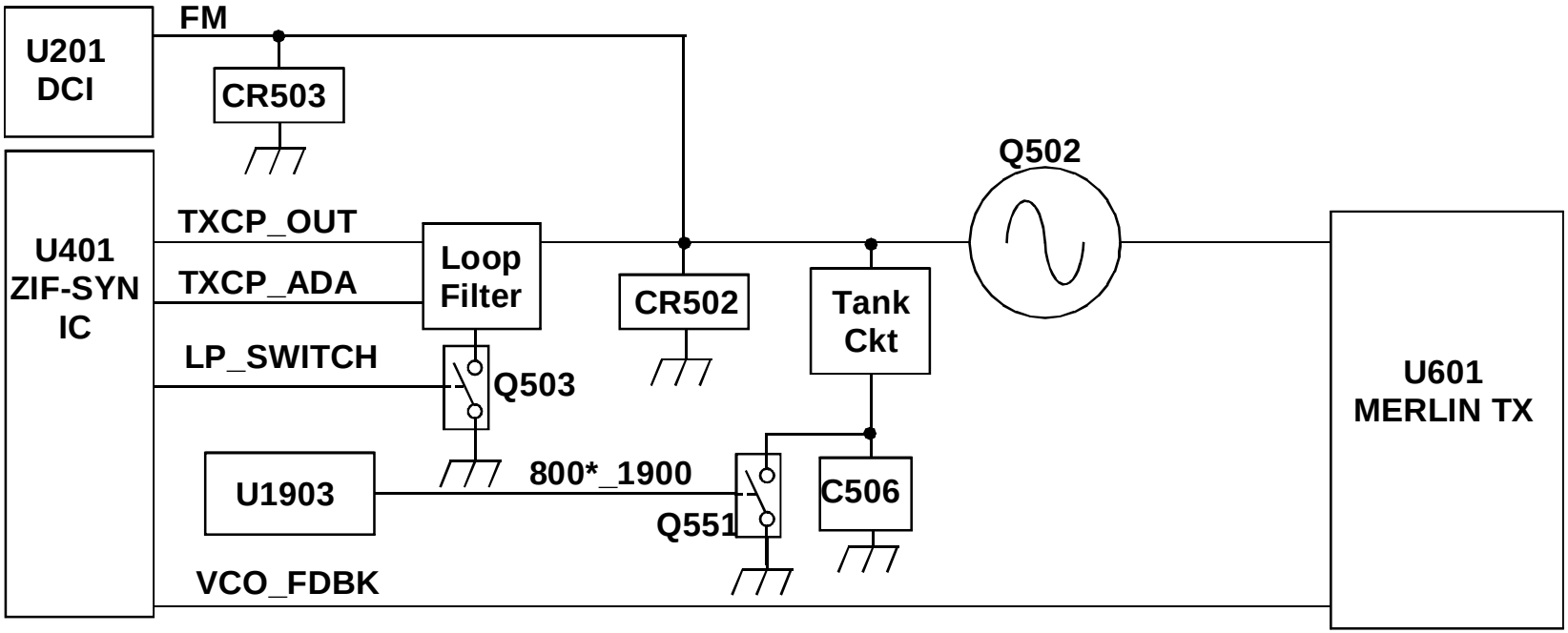
OUT — 1 — 2 — 3 — NC

U401 page B7 — RX_PRE_IN — -11.87 dBm 1026.165MHz — -7.27 dBm 993.31MHz — R304 — R323 — R307 — C147 — R155

MAIN_LO — C120 page B5 — -11.11 dBm 1026.165MHz

DBLR_IN — L144 page B5 — -8.45 dBm 993.31MHz

TDMA M3090/M3097: TX Offset Oscillator



Description

The offset oscillator frequency is controlled by U401(ZIF/SYN) via **TXCP_OUT**. The operating frequency will depend on the dc biasing of CR502. The offset oscillator frequency is 157.32MHz in 800MHz mode, and 192.36MHz in 1900MHz mode and is controlled by 800*_1900. The **LP_Switch**, which comes from U401, changes the bandwidth of the **OFF_OSC**. The **LP_Switch** is on in analog mode and off digital mode.

In analog mode the FM signal comes from U201(DCI) pin 39 and is modulated directly in the offset oscillator. The offset oscillator with the FM then enters U601 (QMOD). The Quadmod (U601) will feed back the offset frequency to U401 for proper PLL operation.

TDMA M3090/M3097: TX Offset Oscillator

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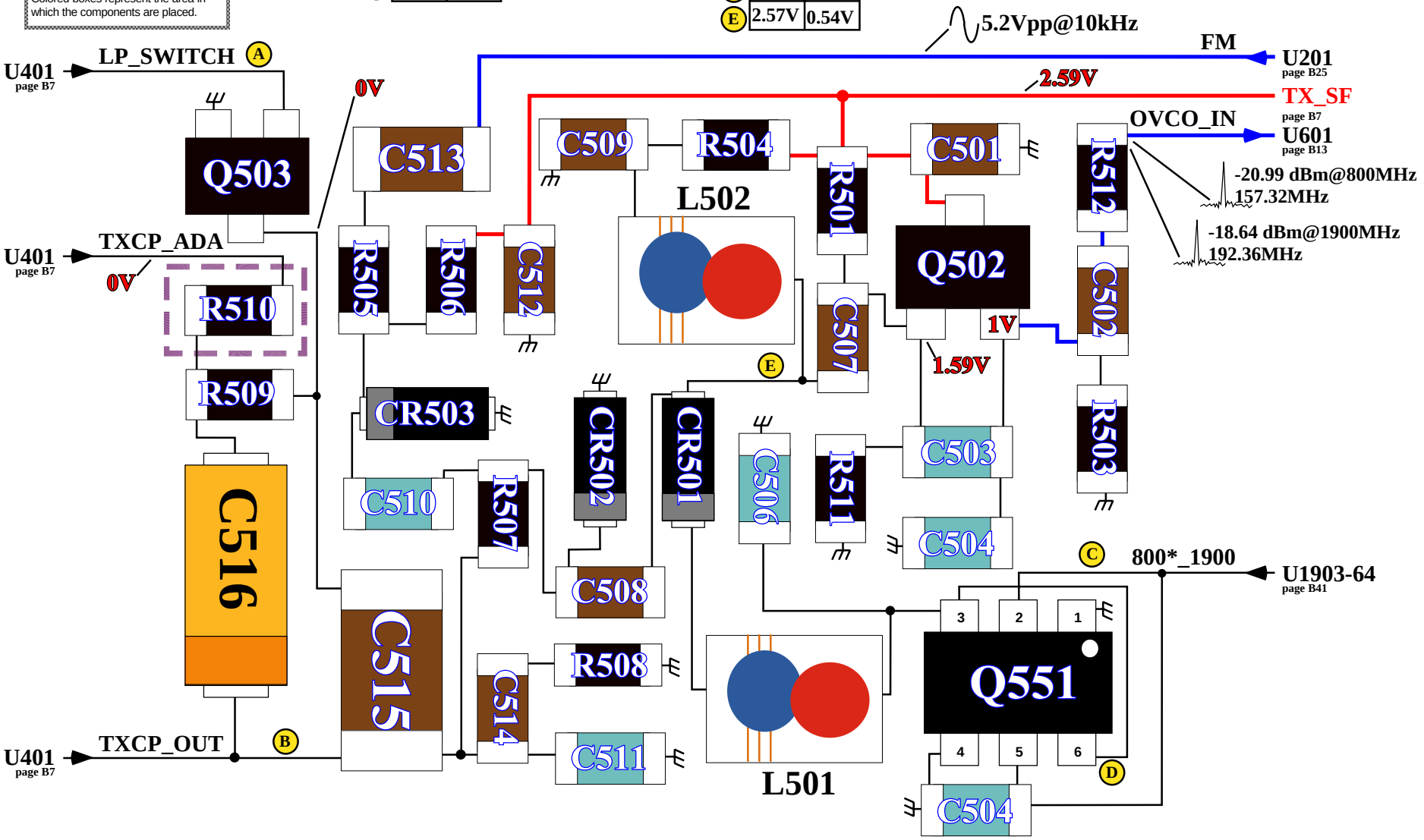
Channel: 333
Cellular TX Input Freq: 157.32MHz
PCS TX Offset Freq: 192.36MHz
TX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

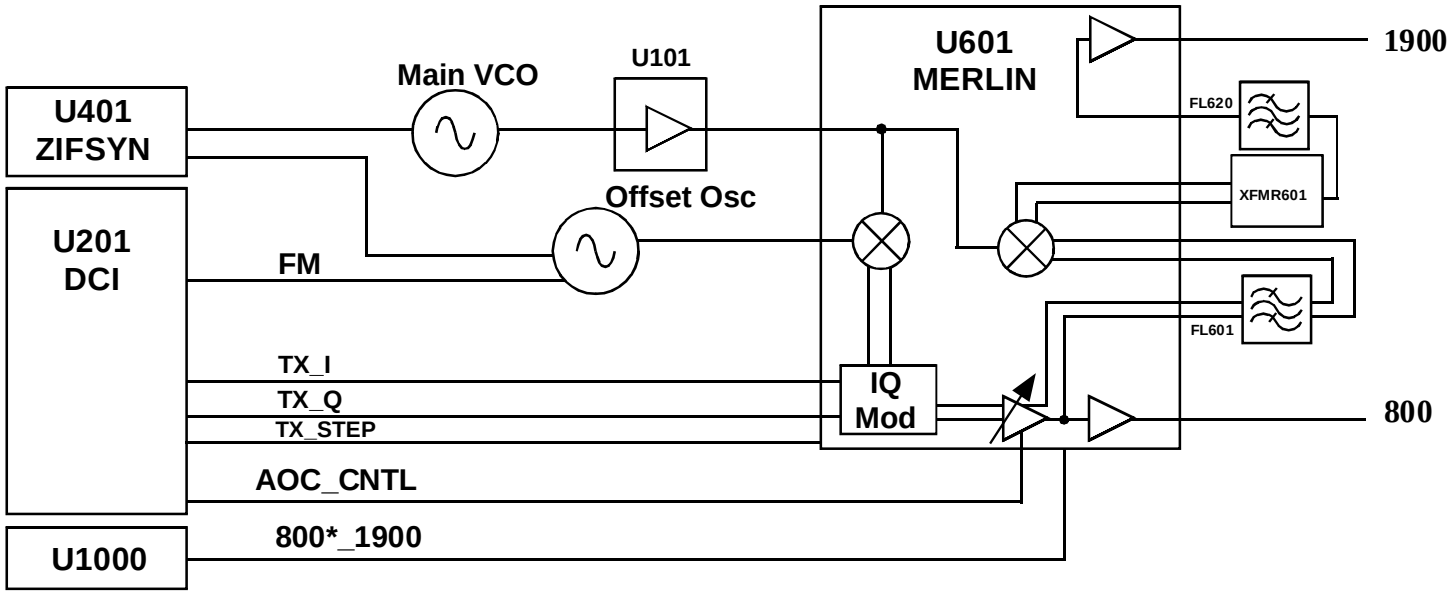
	Analog	Digital
A	2.8V	0V

Band	800	1900
B	2.1V	1.84V
C	0V	2.78V
D	2.92V	0V
E	2.57V	0.54V



B11

TDMA M3090/M3097: MERLIN (U601)



B12

Description

U601 is a TX modulator. It takes the TX information and modulates it on a carrier for RF transmission.

In analog mode the offset oscillator with the FM enters U601 and gets mixed with the main VCO. The resulting signal is a differential carrier with the modulated information. The carrier is then passed through an IQ modulator. The **A_D** line from the DCI (U201) controls the state of the IQ modulator. In analog mode, the IQ modulator simply feeds the carrier though to a voltage controlled amplifier(VCA). The gain of the VCA is controlled via the **AOC_CNTL** line, therefore, controlling the TX power steps of the transceiver. Once the carrier passes through the VCA, it passes through the cellular final power amplifier which is still internal to U601.

In digital mode the offset oscillator doesn't contain the modulated information from the FM line. The offset oscillator is mixed with the main VCO and a differential out-put signal is sent through the IQ modulator. In digital mode, the **A_D** line configures the IQ modulator to allow IQ modulation to the carrier. The result carrier signal is then passed through the Voltage Controlled Amplifier(VCA). The gain of the VCA is adjusted by the **AOC_CNTL** line, thus controlling the TX digital power steps of the transceiver.

When operating in the 800MHz band the carrier is routed through the cellular final power amplifier and out to the 800MHz transmit circuit. In 1900MHz mode the cellular final power amplifier is disabled via the 800*_1900 line and the VCA output is routed to filter FL620 for noise and spurious performance improvement. The differential out-put is then routed into a PCS upconverter where the signal is upconvertered to a PCS frequency by mixing the carrier signal with the main VCO. The output of the PCS upconverter is then routed to a Balun (XFMR601) for single ended signal conversion. The newly created single ended TX carrier signal is then filtered by FL601 and routed through the PCS power amplifier internal to U601 before entering the 1900 TX exciter circuit.

The **TX_STEP** line is used to control the biasing to the cellular final amplifier, PCS final amplifier, and the PCS upconverter. This line is used as a course gain control for the final amplifiers and PCS upconverter.

TDMA M3090/M3097: MERLIN (U601)

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Channel: 333
Cellular TX Freq: 834.99MHz
PCS TX Freq: 1859.97MHz

VCO SIGNAL
TX SIGNAL
VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

B13

FL601 (IN / OUT)

-21.5dBm 1859.97MHz

-30.47 dBm@800MHz 992.31MHz

-9.35 dBm@1.9GHz 1027.13MHz

-17.79 dBm 1859.97MHz

R353 page B5 — BUFF_VCO

TX_2.75V page B27 — 2.75V

C608, XFMR601, C607, C606, R603, C604, C605, L607, C609, C610, C840, C622, C620, L620, C621, L621, C652, C653, C603, R621

1.7V

2.79V

VCC_OFFSET, OVCO_E, U601, OVCO_OUT, OFFSET2

-15.59 dBm 1859.97MHz — 1900_OUT — R835 page B15

-1 dBm 834.99MHz — 800_OUT — C719 page B15

U1903-64 page B41 — 800*_1900 (A)

R512 page B11 — OVCO_IN

TX_2.75V page B27 — 2.75V — L601, R601, L651

U201-17 page B25 — TX_STEP

FL620

-27.74 dBm 833.805MHz

-33.11 dBm 833.805MHz

C602, C623, C624, C626, C625

TX_I — U201-38 page B25

TX_IX — U201-37 page B25

TX_Q — U201-42 page B25

TX_QX — U201-41 page B25

U201-20 page B25 — QMOD_KEY (B)

U201-30 page B25 — AOC_CNTL (C)

U201-14 page B25 — A_D

C627, R623, R622, C629

TX_SF page B7 — 2.59V

L602

-18.79 dBm@PCS 192.36MHz

U401 page B7 — TXPRE_IN — C418

-15.66 dBm@Cellular 157.32MHz

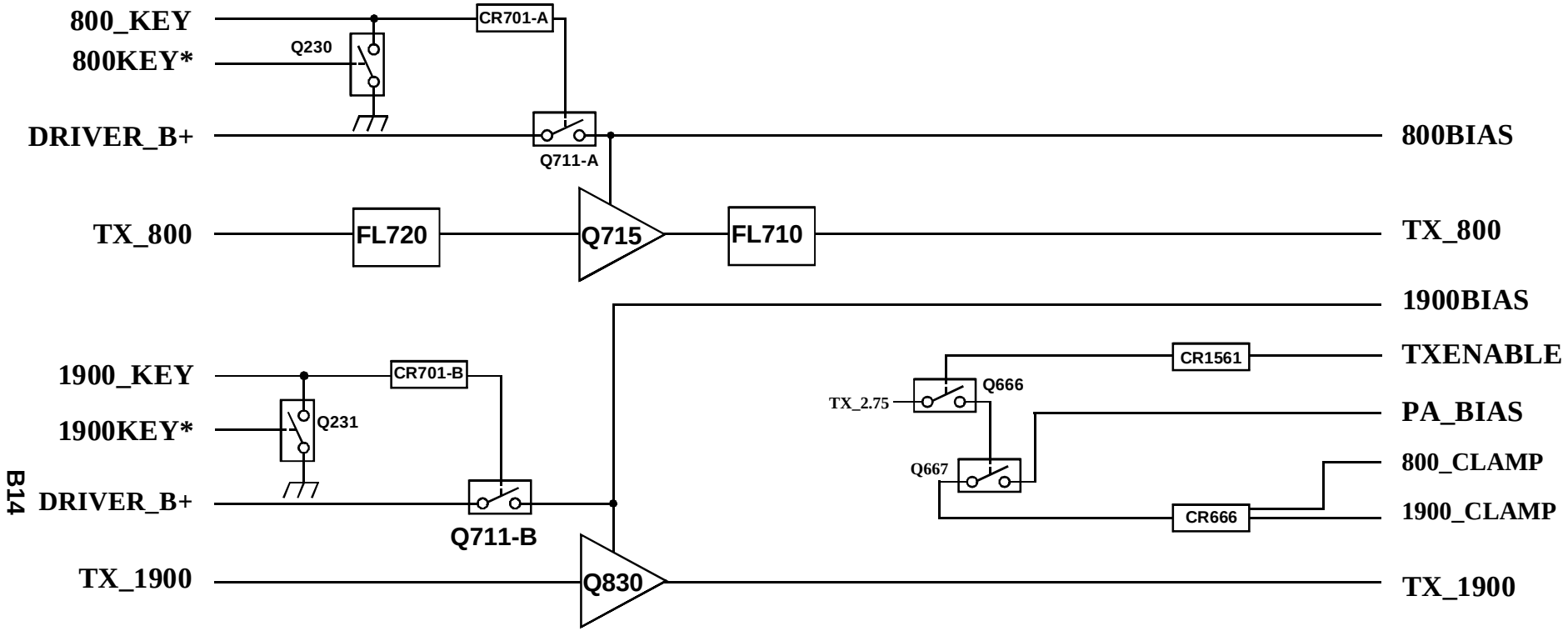
TX_2.75V page B27 — 2.75V

Band	800	1900
A	0V	2.73V

TX	On	Off
B	0V	2.76V

Power Step	2	3	4	5	6	7
C	1.7V	1.54V	1.39V	1.26V	1.45V	1.32V

TDMA M3090/M3097: Amp Drivers



Description

After the desired transmit information is modulated with a TX carrier frequency, enough signal power needs to be provided for RF transmission through the antenna. The driver stage is used to relieve amplification of the final stage PA. This reduces excess heat dissipation and overloading of the final stage PA.

In 800MHz mode, the TX signal passes through FL720 and then is amplified by Q715. Q715 is driven on by suppling **DRIVER_B+** through Q711-A. Q711-A can be switched on or off via the **800KEY** line. While transmitting in 800MHz mode, **800KEY*** becomes high causing Q230 to turn on and shorting **800KEY** to ground. This state brings the gate of Q711-A to a low level, causing Q711-A to switch on.

In 1900MHz mode, the TX signal is amplified by Q830. Q830 is driven on by suppling **DRIVER_B+** through Q711-B. Q711-B can be switched on or off via the **1900KEY** line. While transmitting in 1900MHz mode, **1900KEY*** becomes high causing Q231 to turn on and shorting **1900KEY** to ground. This state brings the gate of Q711-B to a low level, causing Q711-B to switch on.

1900BIAS provides the proper biasing voltage for the final stage PA(U801).

TXENABLE comes from the DCI and turns on your PA via the 800_SUPPLY in 800MHz mode and via 1900_SUPPLY in PCS mode.

The clamping circuit protects both the 1900 MHz and 800MHz PAs from an unexpected high B+ voltage condition.

TDMA M3090/M3097: Amp Drivers

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B15

R682 page B17 — 1900_KEY — A
R681 page B17 — 800_KEY — B
U1903-61 page B41 — 1900KEY* — C — Q231
U1903-62 page B41 — 800KEY* — D — Q230

C833, C834, R833, L831, L830, CR701
R834, C835, L832, C836, Q830, C831, C830
-24.87 dBm@PCS 1859.97MHz → R830 page B17

R802 page B17 — 1900_BIAS — 0.98V
C840 page B13 — 1900_OUT
R835, Q711, R712, R832
3V → DRIVER_B+ page B31
800_BIAS → Q723 page B19 — G
3V
DRIVER_B+ page B31
-32.21 dBm@PCS 1859.97MHz

U601-7 page B13 — 800_OUT
-8.68 dBm@Cellular 834.99MHz
C719, FL720, R716, R715
C717
-16.63 dBm 834.99MHz

Band	800	1900
A	4.92V	
B		4.9V
C	0V	
D		0V

Channel: 333
Cellular TX Input Freq: 879.99MHz
PCS TX Input Freq: 1940.01MHz
TX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

L712, R714, C716, R713, C715
0.356V — Q715, L711
-7.07 dBm 834.99MHz
0.7V — C712, L710

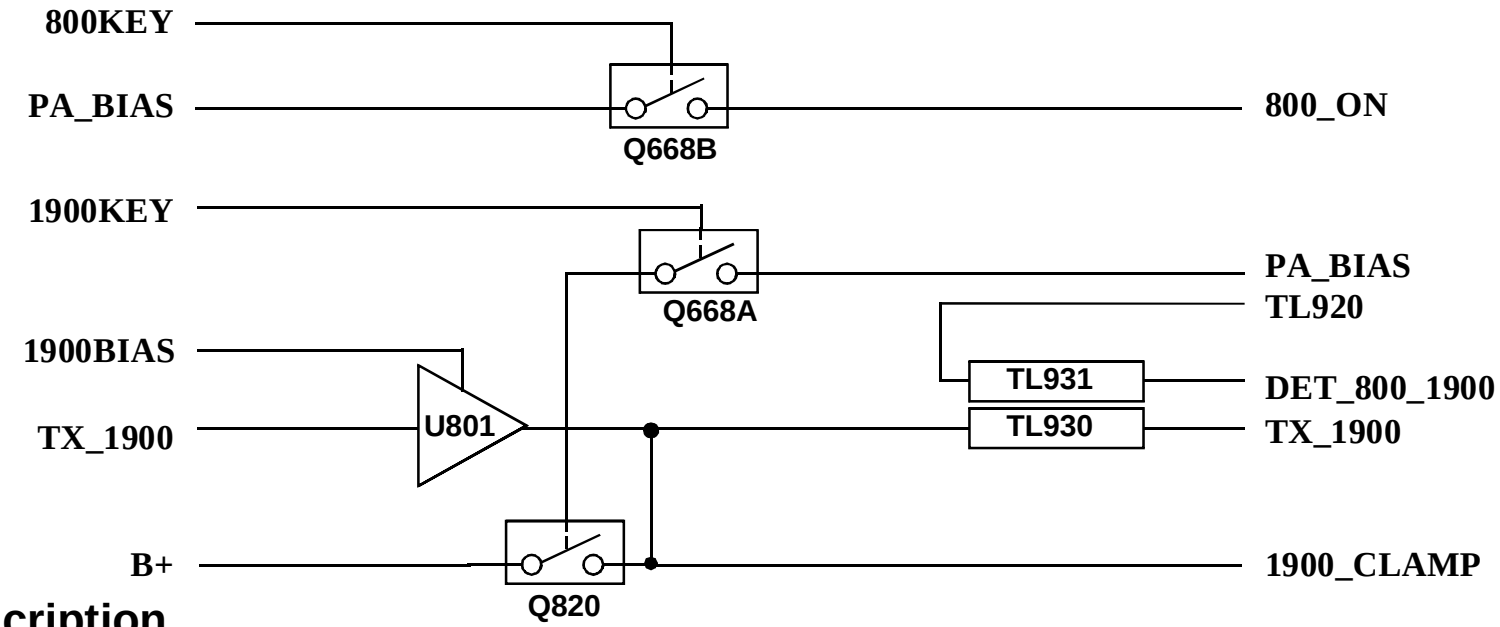
	Analog	Digital
G	3.04V	1.07V

U201-21 page B25 — TXENABLE — E
TX_2.75 page B27 — 2.75V — Q666, CR1561, R667
Q668 page B17 — PA_BIAS — F — 3Vpp
R668, C666, Q667, R669, CR666
FL710
-7.02 dBm 834.99MHz
TX_800 → R710 page B19

TX	On	Off
E		2.76V
F		0V

R673 page B19 — 800_SUPPLY — 1.8Vpp
R676 page B17 — 1900_SUPPLY — 1.8Vpp
1.6Vpp

TDMA M3090/M3097: PA Circuit (1900 MHz)



Description

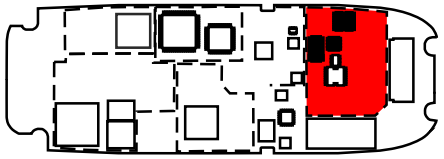
The final stage PA circuit provides the necessary amount of power for RF transmission through an antenna. U801 is a PA module that is capable of operating in the 1900MHz band digital mode.

Q820 controls the supply voltage to U801. The PA supply is sourced from the B+ line. In 1900MHz mode, 1900KEY voltage drops causing Q820 to switch on. In 800MHz mode, 1900KEY is pulled high, Q820 is turned off and the supply to U801 is cut off.

After the TX carrier is amplified it's sent to the duplex filter for final transmission through the antenna.

In order to maintain a accurate power level, an RF detect circuit is used to monitor the signal level being transmitted. A single RF detect circuit is used for both transmission paths, 800MHz and 1900MHz.

TDMA M3090/M3097: PA Circuit (1900MHz)

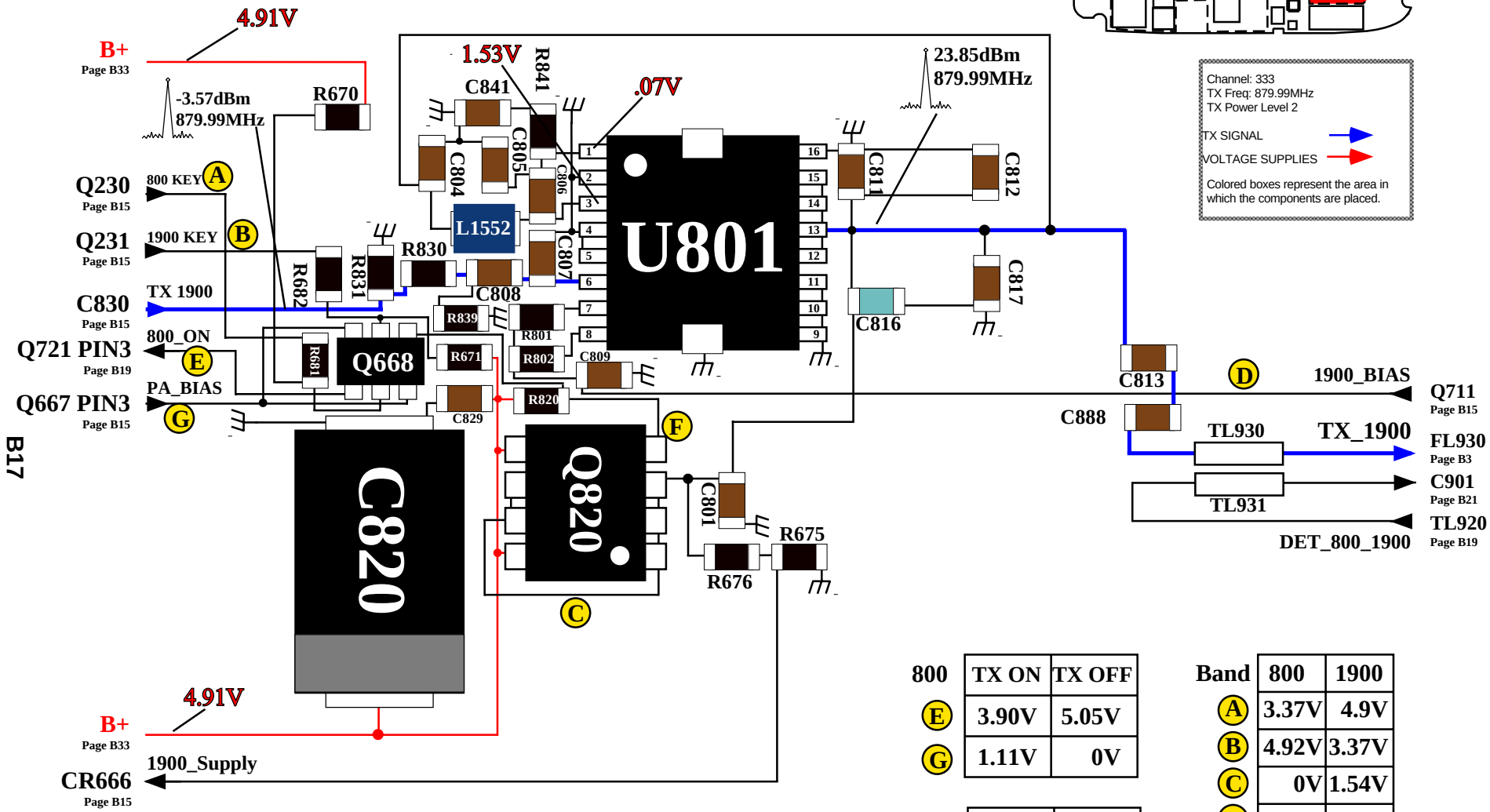


Channel: 333
TX Freq: 879.99MHz
TX Power Level 2

TX SIGNAL

VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.



800	TX ON	TX OFF
E	3.90V	5.05V
G	1.11V	0V

1900	TX ON	TX OFF
F	3.90V	5.05V
G	1.13V	0V

Band	800	1900
A	3.37V	4.9V
B	4.92V	3.37V
C	0V	1.54V
D	0V	.98V

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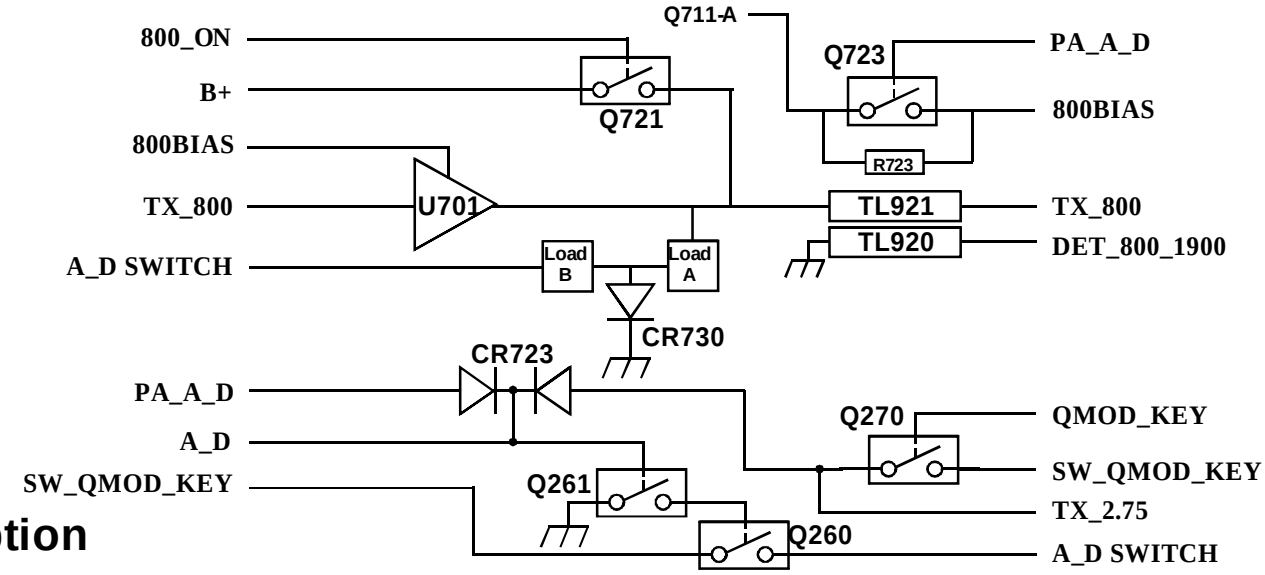
TDMA M3090/M3097: PA Circuit (800MHz)



Description

B18

The final stage PA circuit provides the necessary amount of power for RF transmission through an antenna. U701 is a PA module that is capable of operating in the 800MHz band under analog or digital mode. In analog mode linearity of the PA is not as critical as when operating in digital mode. For this reason, efficiency is a more important factor than linearity when operating in analog mode. In digital mode, because of its IQ modulation scheme, PA linearity is a more important factor than efficiency. Efficiency and linearity is controlled by varying the biasing of the PA (U701).

Q721 controls the supply voltage to U701. The PA supply is sourced from the B+ line. In 800MHz mode, 800_ON the voltage is decreased causing Q721 to switch on. When 800_ON is pulled high, Q721 is turned off and the supply to U701 is cut off. After the TX carrier is amplified it's sent to the duplex filter for final transmission through the antenna. In order to maintain a accurate power level, an RF detect circuit is used to monitor the signal level being transmitted. A single RF detect circuit is used for both transmission paths, 800MHz and 1900MHz.

The switching circuit defines the proper PA loads when in 800MHz analog and 800MHz digital mode. Q270 is a FET switching circuit which allows SW_QMOD_KEY to be sourced from the TX_2.75 supply. During non-transmit states, Q270 is switched off by pulling QMOD_KEY high. This state will not allow SW_QMOD_KEY to be sourced from TX_2.75, thus reducing unnecessary current consumption in numerous TX circuits that use the SW_QMOD_KEY supply.

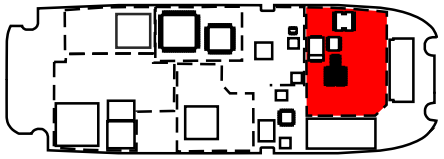
When transmitting in 800MHz analog mode, LOAD A is used and LOAD B is bypassed. LOAD B is bypassed by allowing CR730 to be forward biased. Forward biasing CR730 will provide a ground state at the anode side, thus allowing only LOAD A to be present.

CR730 is forward biased by having a supply voltage present at the AD_SW line. When the A_D line is pulled down, Q261 is switched on, forcing the base of Q260 low. PNP transistor Q260 will then be switched on, allowing the output(AD_SW) to be pulled high from SW_QMOD_KEY.

PA_A_D line controls the PA biasing in 800MHz digital and analog mode.

There are two operating modes in the 800MHz band, analog and digital. The **800BIAS** voltage level determines the operating condition of the final stage PA. A lower voltage level at **800BIAS** denotes digital mode and a higher voltage level denotes analog mode. In analog mode, **PA_A_D** is pulled high causing Q723 to be switched on. This state causes R723 to be bypassed, thus, having a high voltage level at **800BIAS**. In digital mode **PA_A_D** is pulled low causing Q723 to be switched off. During this state R723 has a voltage drop across it and **800BIAS** will have a lower voltage level.

TDMA M3090/M3097: PA Circuit (800MHz)



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Channel: 333
TX Freq: 879.99MHz
TX Power Level 2

TX SIGNAL

VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

Band	800	1900
A	3.92V	4.92V
B	1.55V	0V
C	1.0V	0V
D	0.19V	0V

	Analog	Digital
C	1.98V	1.0V
D	2.91V	0.19V
E	2.91V	.20V
F	2.75V	0V
G	1.98V	1.0V
H	0V	1.23V

	TX ON	TX OFF
I	0V	2.76V
J	0V	2.72V

Q668 PIN 4 Page B17 — 800_ON (A)

B+ Page B33 — 4.8V

CR666 PIN2 Page B15 — 800_Supply

FL710 Page B15 — TX_800

CR723 Page B19 — PA_A_D (E)

Q711 Page B15 — 800_BIAS (D)

Q260 Page B19 — A_D SWITCH (C)

Q723 Page B19 — PA_A_D (E)

U201-14 Page B25 — A_D (F)

U201-20 Page B25 — QMOD_KEY (I)

TX_2.75 Page B27 — 2.74V

B19

-1.25dBm 879.99MHz

0.2V

-1.59 dBm 879.99MHz

1.51V

23.56dBm 879.99MHz

R720, Q721, C703, L701, C704, C729, R747, R674, R673, C706, C705, C707, U701, C722, C727, C701, R711, R710, L741, R741, C744, C711, C710, L702, Q723, R724, R723, R701, R703, C709, C726, C731, C730, L730, CR730, C158, CR723, Q261, C260, Q260, R730, R920, L740, C741, C740, R740, R1915, Q270, C261, TL921, TL920

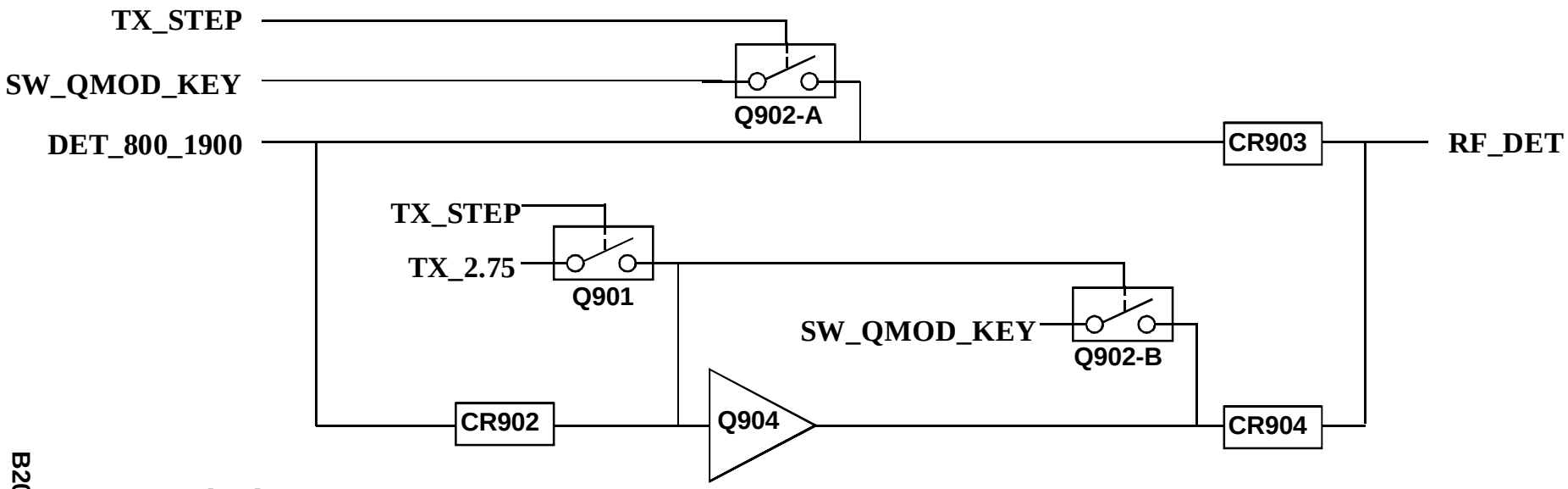
TX_800 → FL931 Page B3

DET_800_1900 → TL931 Page B17

G — A_D SWITCH → R730 Page B19

J — SW_QMOD_KEY → U101-17, R902 Page B5 Page B21

TDMA M3090/M3097: RF Detect Circuit



B20

Description

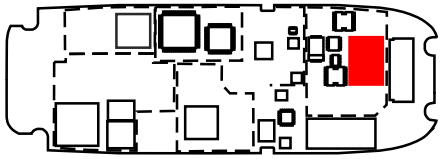
The RF detect circuit is used to detect the RF amplitude level of the TX signal. RF detect reports back to U201 (DCI) pin 31, using a dc level, for amplitude stabilization. The RF detect circuit is RF coupled with the TX signal from either band, 800MHz or 1900MHz. The RF input is then converted into a dc level and sent to the **RF_DETECT** line. There are two stages in the RF detect circuit which are used to increase the dynamic range of the RF detect output. The two stages are controlled by the **TX_STEP** line input. **TX_STEP** is high when power steps 0 through 5 are used . **TX_STEP** is low when power steps 6 through 10 are used .

When **TX_STEP** is low Q902-A is switched off and Q901 is switched on. Since Q902-A is switched off , the supply to diode CR903 gets cut off thus not forward biasing CR903 and not letting any signal through. By Q901 being switched on, it supplies the desired current to amplifier Q904 and at the same time Q901 also switches Q902-B on. Having Q902-B on will forward bias diode CR904, letting the signal through.

When **TX_STEP** is high Q902-A is switched on and Q901 is switched off. Since Q901 is switched off, the supply to amplifier Q904 is cutoff and also Q902B is switched off, thus not forward biasing CR904 and not letting any signal flow through. Having Q902-A on will forward bias diode CR903 letting the signal through.

In summary, during high power steps the signal is sent directly to the **RF _DET** output through CR903. During low power steps the signal passes through amplifier Q904 and then sent to the **RF_DET** output through CR904.

TDMA M3090/M3097: RF Detect Circuit



R908

R206 Page B25 — RF_DET (B)

CR904 — C912 — CR903 — C901 — 0V

(D) — R907 — C909 — C911 — R909 — C902 — CR902 — R903 — 2.74V

DET_800_1900 → TL931 Page B17

Channel: 333
TX Freq: 879.99MHz
TX Power Level 2

VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

Power Step	2	3	4	5	6	7
A	2.73V	2.73V	2.73V	2.73V	0V	0V
B	1.23V	.87V	.63V	.46V	1.36V	.96V

B21

C906 — C907 — R906 — Q904 — R901 — L901

TX_2.75 Page B27 — 2.74V

L903 — C910 — L902 — 0V — (E) C903

TX_STEP	ON	OFF
C	0.26V	0.60V
D	0.65V	0.06V
E	0.24V	1.24V
F	0.27V	2.71V

C908 — R905 — R904 — C905

TX	ON	OFF
G	2.70V	0V

Q902 — CR901 — R902 — C904 — Q901 — 2.74V

(C)

Q270 Page B19 — SW_QMOD_KEY (G)

TX_2.75 Page B27

TX_STEP (A) → U201 Pin17 Page B25

(F)

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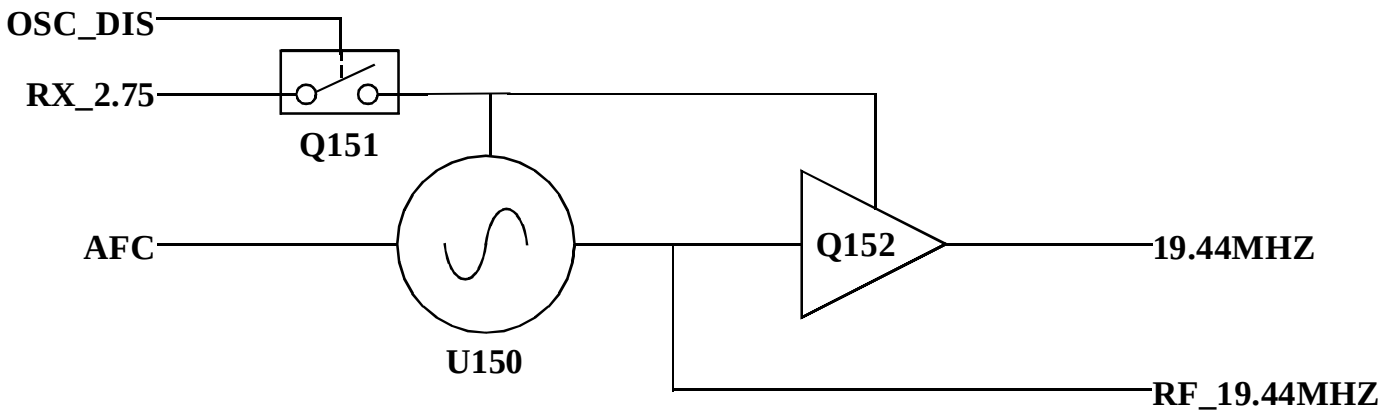
TDMA M3090/M3097: Reference Oscillator



B22

Description

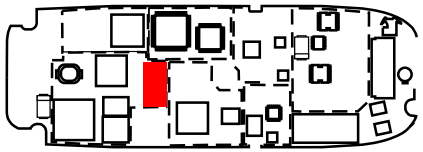
The reference oscillator U150, operating at 19.44MHz, provides a "reference frequency" for the RF synthesizers and various logic circuits.

The OSC_DIS line which is controlled by U1000 (CPU) is used to turn off U150 during sleep mode. The OSC_DIS line switches Q151 on or off, controlling the supply voltage to U150 and Q152.

U201 (DCI) can "fine tune" U150 via the AFC line. Tuning of the reference oscillator is needed to synchronize frequencies with the cellular base station, therefore, the signal received from the base will be used to determine the correct reference frequency.

The output of U150 is split into two signals. RF_19.44MHz is used for the RF frequency reference. Output 19.44MHz is amplified by Q152 and then sent to the logic section for logic clock synchronization.

TDMA M3090/M3097: Reference Oscillator



VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

2.66V

0V

U1000 page B43 — OSC_DIS

R151

C151

Q151

2.72V

RX_2.75V page B27

19.44MHz → U1500,C1917 page B27 page B41

C150

C153

-11 dBm

19.44MHz → C201,C1908 page B25 page B39

L150

0.9V

R153

R152

U201-29 page B25 — AFC

1.36V

U150

2.66V

Q152

C160

0.35V

C152

R154

C414 page B7 — RF_19.44MHz

-10 dBm

B23

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TDMA M3090/M3097: DCI (U201)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B25

Description

The DCI (U201) is data converter interface between the DSP and the RF functions of a dual band TDMA transceiver. It incorporates the following functions:

- Dual channel forward data I and Q(RX_I & RX_Q)
- Two DACs for reverse data I and Q(TX_I & tx_Q)
- DAC for AFC
- DAC for AGC & DAC for reverse PA control
- DAC for PA bias
- Serial Synchronous Interface(SSI)
- Serial Peripheral Interface(SPI)
- Countdown timer for call processor wake-up
- Free-running Real Time Counter to keep track of the time when control processor is stopped
- Internally generates clocks from single master input
- Power saving power-down modes
- Analog wide band forward data signalling functions with SPI interface
- Analog modulator interface
- Analog discriminator interfaces
- RF Discontinuous Receive during Manchester decoding
- On chip voltage reference for transmit I and Q

TDMA M3090/M3097: DCI(U201)

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TX	On	Off
D	0V	3.77V
G	0V	2.75V
F	0V	2.76V

C513 page B11 — FM — 5.2Vpp@10kHz — 440mV

U601 page B13 — TX_QX

U601 page B13 — TX_Q — 2.82V

2.75V page B27 — SCLK

U1900 page B39 — AGC_STEP (K)

U401 page B7 — RESET — 2.79V

U1000 page B43 — BATT_SAV (A)

Q1571 page B29

Sleep Mode	On	Off
A	2.7V	0V

2.77V — RX_2.75V page B27

U1900 page B39 — FS

U1900 page B39 — TXDATA

U1900 page B39 — RXDATA

U1900 page B39 — IRQ

U1000 page B43 — MISO

U1000 page B43

	Analog	Digital
B	2.87V	0V

U1000 page B43 — MOSI

U1000 page B43 — CLK

U1000 page B39 — SS1

U1000 page B43

RX	On	Off
E	2.73V	0V

U601 page B13 — A_D (B)

U601 page B13 — TX_STEP (C)

Q1102 page B31 — EXT_EN (D)

C153 page B23 — 19.44MHz — 1.3Vpp

2.75V — TX_2.75V page B27

R159 page B5 — FE_EN (E)

Q212 — R209 — R212 — C201 — R201 — R202

U201

Pin	Name
1	TX DATA
2	RX DATA
3	
4	
5	
6	NC
7	
8	
9	
10	
11	
12	NC
13	NC
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	NC
28	
29	AFC
30	
31	RF_DET
32	
33	
34	RBIAS
35	VREEBUF
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	

TX_I — 440mV — TX_IX

U601 page B13 — U601 page B13

Q201 — 0V — INTEG_EN — U1900 page B39

RX Input	<-51dBm	>-39dBm
K	1.77V	2.79V

REF_2.75V page B27 — 2.78V

C203 — 0V

Powers Step	2	3	4	5	6	7
B	1.18V	.855V	.616V	.47V	1.26V	.901V
I	1.7V	1.56V	1.39V	1.25V	1.44V	1.31V

R255 — C205 — 1.9V

Powers Steps	2-5	6-10
C	2.78V	0.06V

R208 — 1.25V

J AGC_RSSI — U401 page B7

C204

I AOC_CNTL — R263 page B13

1.36V — AFC — U150 page B23

R207 — 0.5Vpp — RX_Q — U401 page B7

RX_I — U401 page B7

R206

H RF_DET — CR903 page B21

RX Input	-20	-60	-116
J	2.6V	1.53V	.437V

1.2Vpp

C202 — R205 — 1.38V — R204

DEMOD — U401 page B7

ZIFSYN_REF — U401 page B7

G TX_ENABLE — CR1561 page B15

F QMOD_KEY — U601,Q270 page B13 page B19

TDMA M3090/M3097: GCAP2 (U1500)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B27

Description

The GCAP2(U1500) provides the regulators and start-up functions for the entire radio. The GCAP2 contains the following hardware blocks:

- On/Off control signals to properly activate the radio.
- Bandgap reference voltage
- Audio amplification for the speaker
- Audio amplification for the alert
- Audio amplification for the EXT speaker
- Audio amplification of the microphone
- Audio CODEC
- Op-amps for use in the battery charger
- Internal D/A for the battery charger
- 8 channel, 8 bit A/D
- Real Time Clock
- Linear regulators
  - RX_2.75V for RX circuits
  - 2.75V for logic circuits
  - TX_2.75V for TX circuits
  - 5V for negative regulator
  - REF_2.75V for negative regulator reference
- 3 wire bus A/D
- Battery selection control circuitry

TDMA M3090/M3097: GCAP2(U1500)

U1000 page B43 GCAP_INT
C153 page B23 19.44MHz
U1000 page B43 WDI
B+ page B33
R1588 page B37 MIC_OUT
5V
5.03V
2.8V
2.75V
C1505
C1504
C1531
C1530
R1591
R1504
CR1500
2.77V
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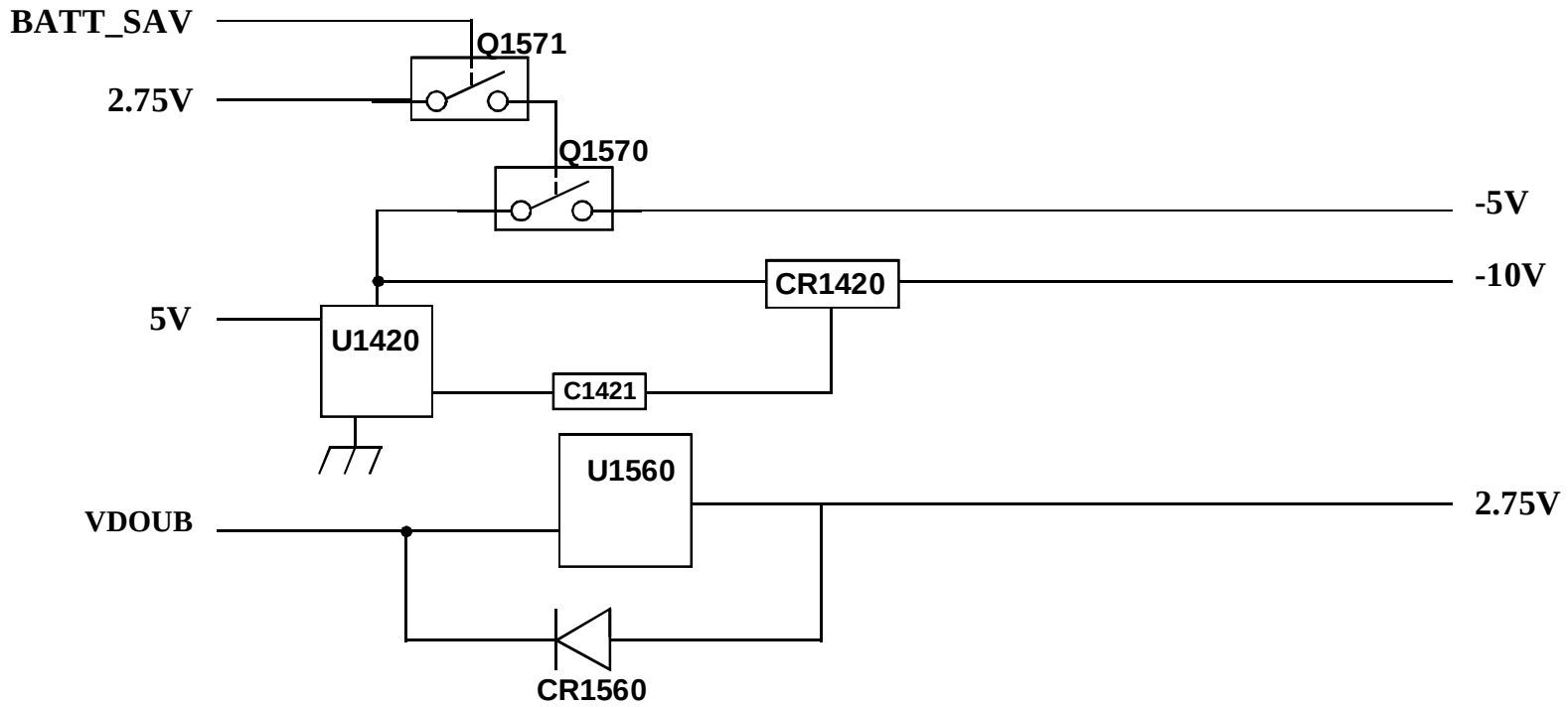
J5 page B49 BATT_THERM
2.8V
4.36V
B27
MIC_BIAS
2.31V
AUDIO_OUT
J2-8 page B49
1Vpp@1kHz
AUDIO_IN
J2-10 page B49
C1534
R1532
R1534
R1530
CR1540
R1531
C1543
C1544
C1540
C1541
C1542
C1533
C1532
R1533
3.4V
L1500
3.4V
R1520
C1520
CR1506
1.38V
VAG
R1511
R1512
2.19V
C1509
5.45V
BATT+ page B49
C1518
C1519
3.42V
V_BUCK
PRE_REG
PA_SENSE
5.1V
AUX_OUT
0.8V
C1565 page B37
C1564 page B37
AUX_MIC
U1000 page B43 SPI_BUS

U1500
LL_CELL
ON2*
MB_CAP
CD_CAP
FB2
SPKROUT
SPKRIN
PA_DRV
MOBPORTB
AD4
CONV_BYP
C1567
C1569
C1550
C1500
C1552
C1553
R1550
R1551
C1551
1.4V
1.38V
C1570
0.6V
C1502
C1503
1.3V
C1507
Y1500
C1506
R1505
R1514
C1508
2.77V
5.36V
1.45V
PWR_KEY
R1515
3.3Vpp
32kHz
U1000 page B43
2.78V
0.4Vpp@32.768kHz
Q1300
5.1V
5.1V
5.36V
2.78V
2.78V
1.2Vpp

MICIN+ R1584 page B37
MICIN- R1585 page B37
ALRTOUT R1554 page B35
MIC_OUT R1588 page B37
ISENSE R1300 page B33
CHRGC R1306 page B33
VDOUB page B29
AGC_RSSI U401 page B7
CMP_LVL U1000 page B35
MAN_LVL R1008 page B35
RESET U1000 page B43
TX_2.75
EXT_B+ page B49
PWR_KEY R1001 page B35
RX_2.75
PRE_REG
B+ page B33
EXT_B+ page B49
REF_2.75V
HDST_SPKR R1561 page B37
SPKR- R1552 page B35
SPKR+ R1553 page B35
CODEC U1900 page B39

TDMA M3090/M3097: Voltage Regulators



Description

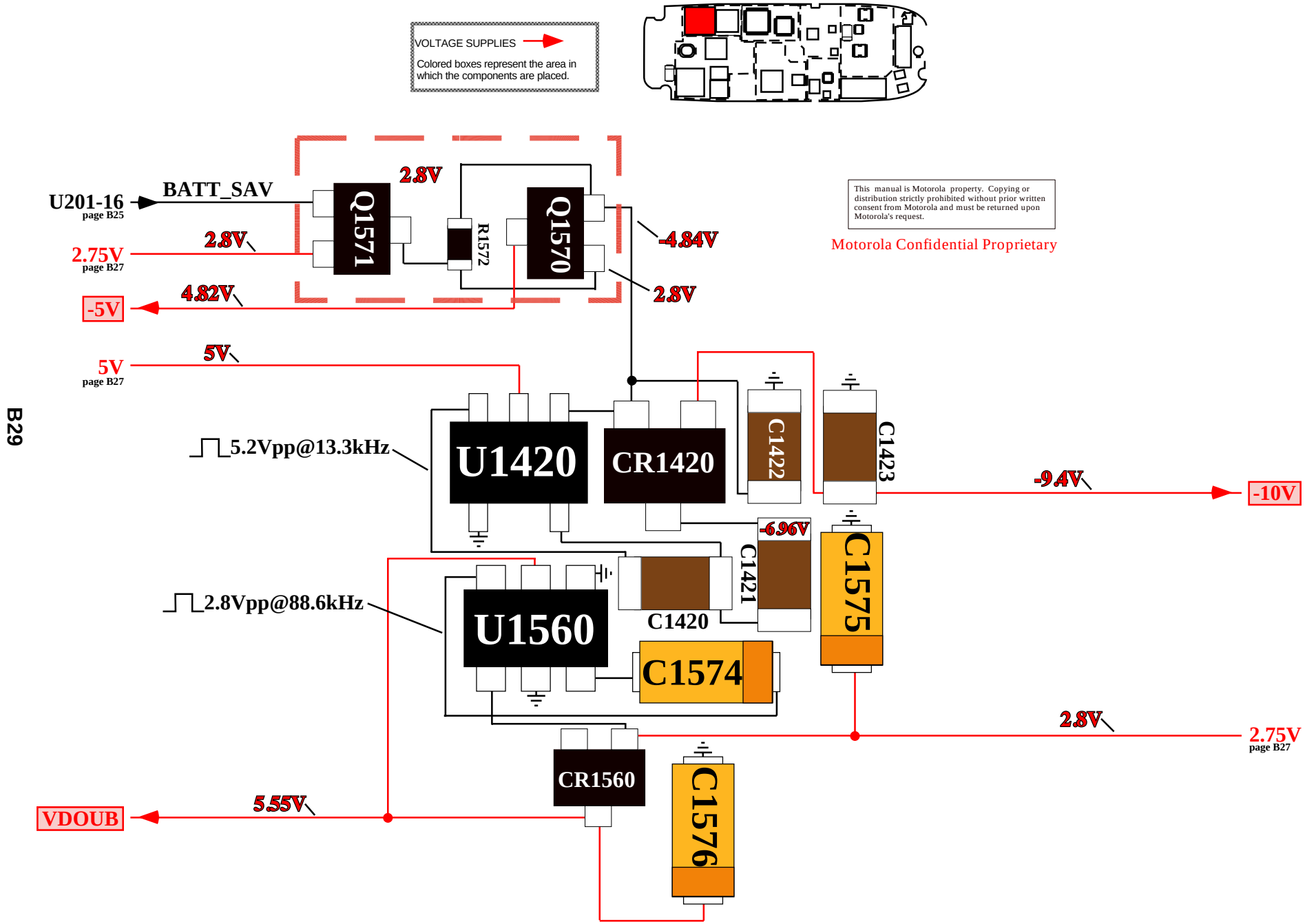
There are some circuits that require a voltage higher than the battery source. For this reason, a voltage doubling charge pump circuit is provided. U1560 takes the 2.75V source and oscillates it with a high peak to peak signal. The positive region of the signal is then sent out to produced the VDOUB supply.

BATT_SAV is used to cut off the -5V supply to the antenna switching circuitry to save battery power. When the BATT_SAV line is on (high), Q1571 switches off, not allowing 2.75V to go through it. This causes a low state at Q1570 causing it to switch off, not allowing the -5V to get to the antenna switching circuitry and vise versa.

U1420 is the negative supply generator. It is used to supply -5V to the antenna switching circuitry and -10V to the display contrast circuitry.

The +5Vp-p square wave output from U1420 gets shifted to -5Vp-p square wave with a -5V reference at CR1420. This shift in reference at CR1420 is caused by -5Vdc output of U1420. The produced squarewave is then rectified by CR1420 causing a -10Vdc output.

TDMA M3090/M3097: Voltage Regulators



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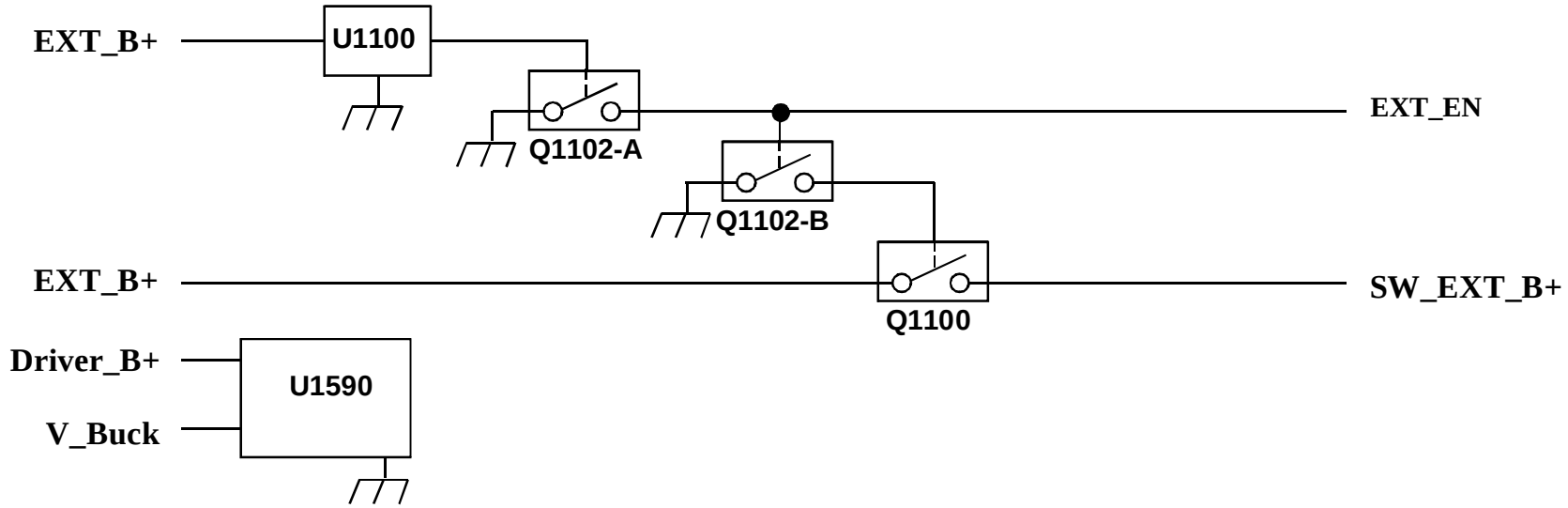
TDMA M3090/M3097: B+ Disconnect / Driver B+



B30

Description

The overvoltage circuit consist of a voltage detector (U1100) and a power switch(Q1100). A resistor divider network at the input of U1100 is used to set the EXT_B+ detect voltage to 9.2V nominal. U1100 outputs low when ever the input voltage is below the detector threshold. During normal operating voltages from EXT_B+ the gate voltage of Q1100 is zero, which turns Q1100 on. When Q1100 is on, SW_EXT_B+ is connected to EXT_B+. When EXT_B+ voltage is above 9.875V nominally, U1100 output becomes open drain. This causes the gate of Q1100 to be pulled up to the EXT_B+, which turns Q1100 off and thus disconnects the voltage to SW_EXT_B+. Q1102-A and Q1102-B act as inverters. Therefore, a low state at the output of U1100 will result with a low state at the gate of Q1100 and vise versa.

The EXT_EN line disables the charging circuit when the phone is transmitting (as when making a call) and connected to a wall charger. It does this by cutting off the SW_EXT_B+ line. This does not occur if the charger is a CLA.

U1590 is a PA Pre-Driver Voltage Regulator that provides 3V to both 800MHz and 1900MHz RF pre-drivers.

TDMA M3090/M3097: B+ Disconnect/Driver B+

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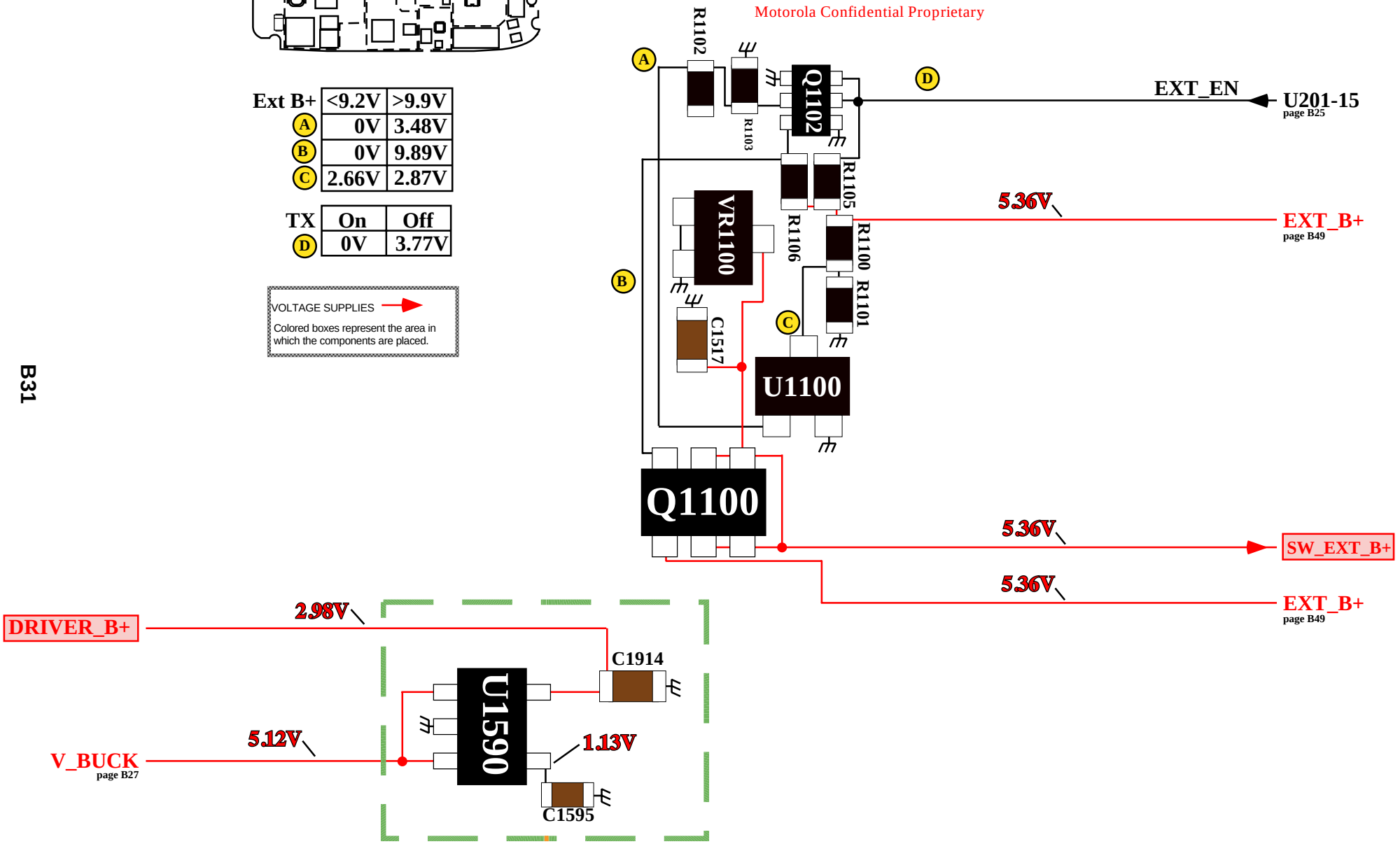
Ext B+	<9.2V	>9.9V
A	0V	3.48V
B	0V	9.89V
C	2.66V	2.87V

TX	On	Off
D	0V	3.77V

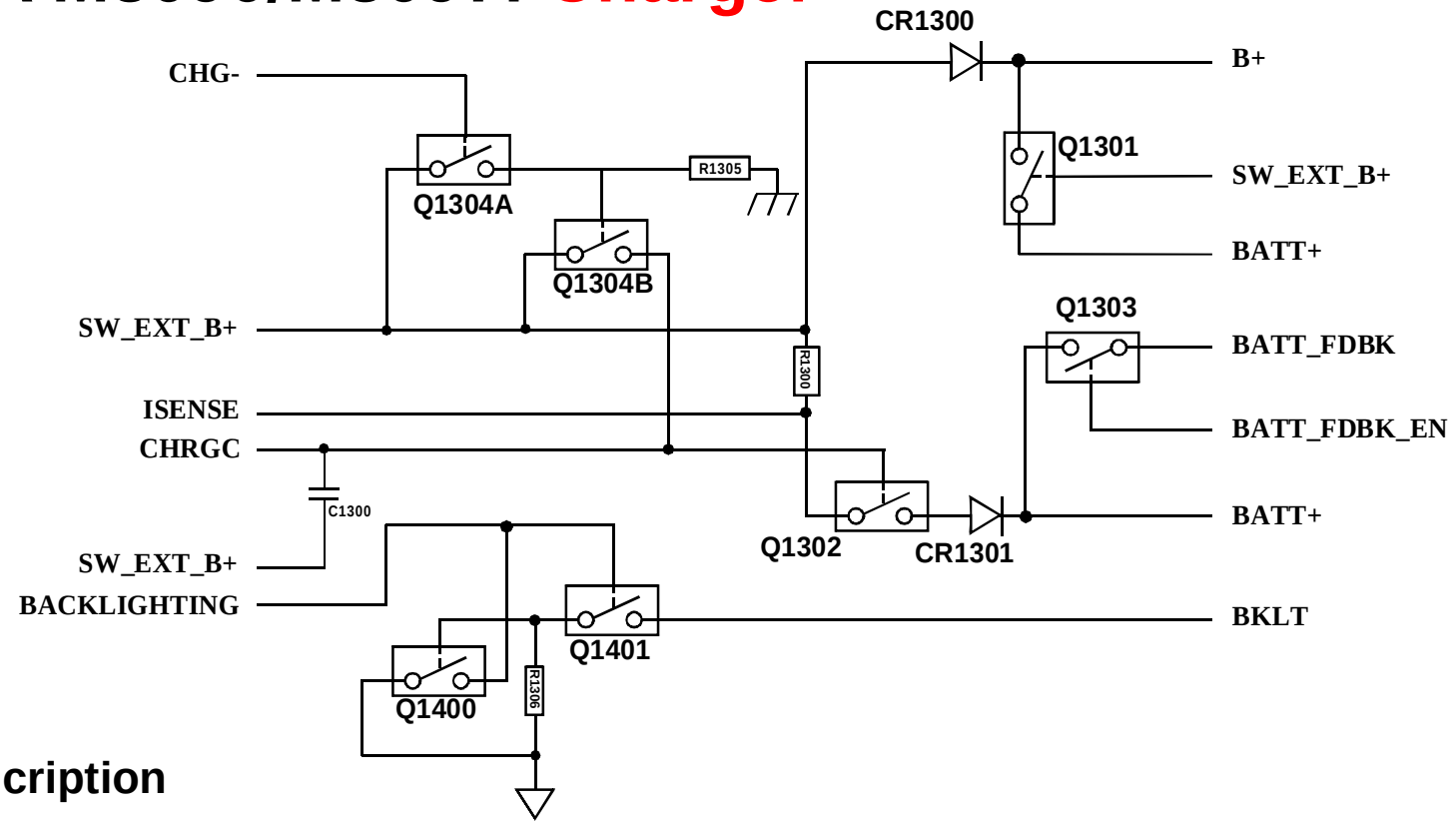
VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

B31



TDMA M3090/M3097: Charger



B32

Description

The internal charger will be activated only when there is an external power source of 8.0V ± 0.4V for the fast charger, 7.05V ±0.35V for the midrate charger, a Motorola battery is attached, and BATT_FDBK is enabled. As SW_EXT_B+ passes thru R1566, U1500 (GCAP) reads the charge current for proper control of the charger. CHRGC controls the rate of charge to the batteries by varying the gate biasing of Q1561. The output of Q1561 is split into two different sections. The one section is the BATT_FDBAK line. BATT_FDBK_EN switches Q642 on or off to disable or enable BATT_FDBAK. When BATT_FDBK is not available, the external supply will lower it's supply to a normal operating voltage and the internal charger will be turned. The second section is the line to charge the batteries.

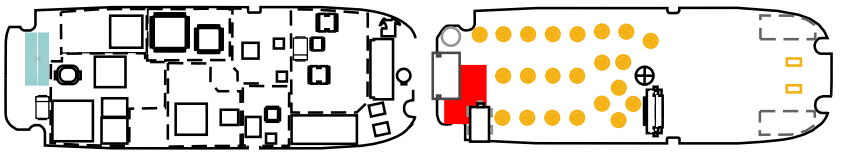
DHFA and CLA are detected by internal pulldown resistors, 3.0Kohm on the MAN_TEST line and 56Kohm on the CMP line for DHFA, 33.2Kohm on the MAN_TEST line for CLA. DHFA/CLA EXTB+ voltage tracks 1.4V above the battery voltage to a maximum of 7.5VDC as long as BATT_FDBK is enabled. If there is no BATT_FDBK, EXTB+ from the CLA or DHFA is 5.4VDC.

CHG- is there to prevent alkaline batteries from ever receiving charge current, which would be a safety concern. Rechargeable Motorola battery packs have this pin tied to BATT_GND. A low at CHG- would switch on Q1304A and switch off Q1304B allowing for battery charging. A high would disable battery charging by forcing the gate of Q1302 with external B+ causing Q1302 to turn off.

Q1301 is simply a switch that determines which power source is going to be used. When SW_EXT_B+ (external B+) is present, Q1301 will be switched off not allowing BATT+ to be the power source. If SW_EXT_B+ is not present, Q1301 will switch on, letting BATT+ be the power source.

The display backlighting is controlled by the Call processor (U1000). U1000 sends a control signal via the BACKLIGHTING line. A high state at the BACKLIGHTING line will switch Q1401 on. This will complete the display circuit's path to ground. As a result, the display backlighting will be illuminated.

TDMA M3090/M3097: CHARGER



VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

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B33

B+ 6.78V

J4 page B49 — CHG- (D) 0V

Battery type	NiMH	Alkaline
(D)	0V	0.19V
(E)	6.96V	3.29V
(F)	0V	7V

LEDS page B47 — BKLT (B)

U1000 page B43 — BACKLIGHTING (A)

SW_EXT_B+ page B31 — 7V

U1500 page B27 — CHRGC (G)

U1500 page B27 — ISENSE

(H) BATT_FDBK → J2-4 page B49

5.45V → BATT+ page B49

(I) BATT_FDBK_EN ← U1903-53 page B41

6.77V → B+

5.45V → BATT+ page B49

7V → SW_EXT_B+ page B31

5.45V → BATT+ page B49

Q1304, C1511, CR1300, Q1401, R1405, Q1303, R1304, C1410, R1403, R1303, Q1400, R1406, C1300, R1302, Q1301, R1305, R1300, Q1302, R1304, CR1301

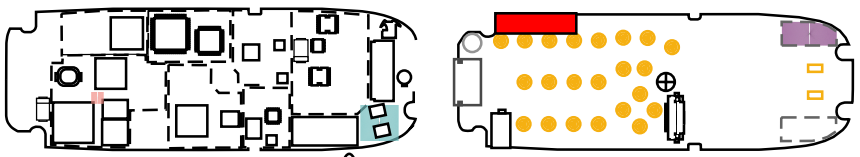
Backlight	On	Off
(A)	2.71V	0V
(B)	3.68V	5.4V
(C)	0.64V	0V

Charger	On	Off
(G)	2.71V	0V
(H)	3.68V	5.4V
(I)	0.64V	0V

TDMA M3090/M3097: Audio/Data Communications

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B35

TDMA M3090/M3097: Audio/Data Communications



1.2Vpp

ALRTOUT → U1500 page B27

C1556

5.07V

PRE_REG page B27

U1500 page B27 — SPKR+

1.2Vpp

U1500 page B27 — SPKR-

C1536 C1535

VR1551 R1552 R1553 VR1550

C1554 L1551 L1550 C1555

R1554 R1555

VR1552 ALERT2

C1559 C1549 C1558

VR1553 ALERT1

1.2Vpp

SPKR

SPKR

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Channel: 333
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm

RX SIGNAL

VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

J2-6 page B49 — CMP 3.62V

U1000 page B43 — CMP_LVL 3.37V

U1000 page B43 — RTN 2.81V

U1000 page B43 — VRH 2.82V

U1000 page B43 — 2.8V

2.75V — TX_DATA

U1000 page B43 — TX_DATA

J2-7 page B49 — 4.58V

PWR page B47 — PWR_KEY

U1500 page B27 — MANUAL_TEST

J2-3 page B49 — 2.8V

2.75V page B27

3.58V

R1012 C1005 C1003 R1001 R1014 R1009 R1011 C1004 R1010 CR1000 R1008 R1013 CR1001

3.36V MAN_LVL → U1000,U1500 page B43 page B27

RX_DATA → U1000 page B43

C1250 C1251 C1006 C1201 C1200 R1003 R1203

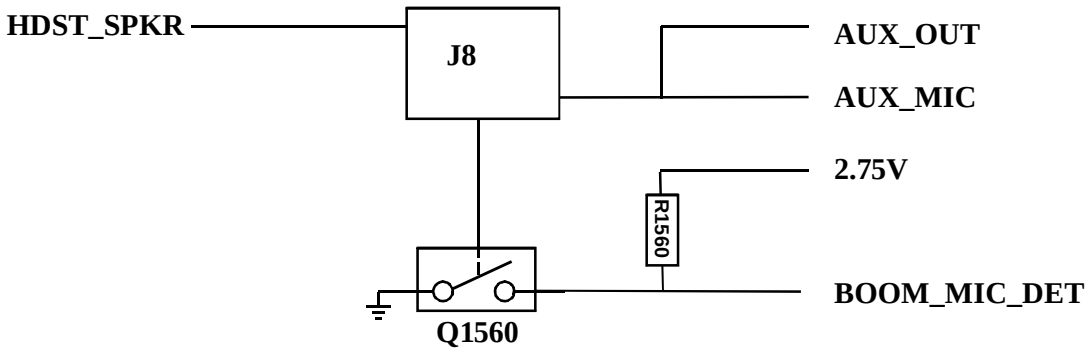
2.8V → 2.75V page B27

2.8V BKGND → U1000 page B43

RX_DATA → J2-5 page B49

B35

TDMA M3090/M3097: Headset/MIC



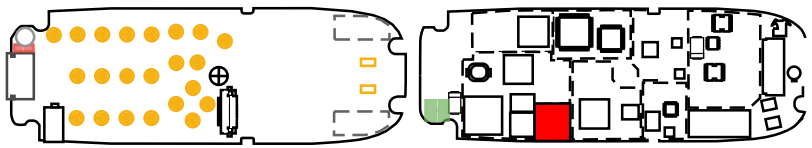
B36

Description

When a headset is inserted in J8, the internal speaker and microphone is disabled. The user can now use the headset for handsfree conversation. BOOM_MIC_DET informs U1000 whether a headset is inserted or not. The state of BOOM_MIC_DET is controlled by Q1560.

When the headset is inserted the biasing voltage for the AUX_MIC will no longer be present at the base of the NPN transistor Q1560. This will switch Q1560 off, thus, allowing BOOM_MIC_DET to be pulled high. When the headset is not inserted, the AUX_MIC biasing voltage is present at the base of Q1560. This condition will switch Q1560 on, thus, pulling the BOOM_MIC_DET to ground.

TDMA M3090/M3097: Headset/MIC



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Channel: 333
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm

TX AUDIO SIGNAL
RX AUDIO SIGNAL
VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

Headset	On	Off
A	0V	1.74V
B	2.79V	0V

B37

J8

B BOOM_MIC_DET → U1000 page B43

2.8V → 2.75V page B27

C1562 C1560 A Q1560 R1560 C1563

C1565 R1562 C1561 R1561 R1563 C1564 R1564

1.2Vpp HDST_SPKR → U1500 page B27

2.31V MIC_BIAS page B27

AUX_MIC- → U1500 page B27

0.8V AUX_OUT → U1500 page B27

U1500 page B27 MICIN- R1585 1.4V

C1587 C1585 C1588 C1584 C1586 C1583 R1583 R1582

MIC_BIAS page B27 2.31V

C1589 R1584 R1588 C1590 R1587 R1586

MICIN+ → U1500 page B27

1.37V VAG page B27

1.4V MIC_OUT → U1500 page B27

TDMA M3090/M3097: DSP (U1900)

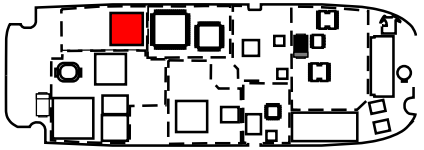
BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B39

Description

The following list is a description of the DSP(U1900):

- ROM Mask Device(48K)
- Patch RAM space(16K)
- Fixed point MAC(multiply accumulator)
- 8-bit parallel interface
- 8-bit control I/O interface
- Dual serial I/O ports
- Two external interrupts
- Flexible power management including Sleep mode, Sleep with slow internal clock, and stop
- **Three modes of operation**
  1. Actively running
  2. Light sleep - Clocks running, but lower power consumption
  3. Deep sleep - All clocks off, extremely low power consumption
- **Digital Traffic Channel**
  1. Acquiring and maintaining synchronization with the Digital Channel
  2. AFC, AGC, AOC control loops
  3. Vocoders (ACELP and VCELP)
  4. Channel equalization
  5. Channel decoding
  6. Channel encoding
  7. Audio functions
  8. MAHO measurements
- **Digital Control channel**
  1. Essentially DTC minus audio and vocoders
  2. ROCM instead of MAHO
  3. Modem goes into deep sleep for long periods
- **Analog Control Channel**
  1. No RX functions - modem in deep sleep
  2. Manchester Encoder
  3. Transmitter control
- **Analog voice channel**
  1. Audio processing
  2. SAT detection/Transponding

TDMA M3090/M3097: DSP(U1900)



VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

U1903 page B41 — MODEM_DATA

U1500 page B27 — CODEC_BUS

U1903 page B41 — MODEM_ADDR

C1902 C1905 C1903 C1906

2.82V

2.75V page B27

C1907

C1900

U1900

VDDA

CLKI

CLKI2

VPP

R1900

R1902

R1923

R1903

R1901

C1901

C1908

R1904

R1914

2.75V page B27 — 2.82V

2.82V

C153 page B23 — 19.44MHz — 1.3Vpp

2.82V DSP_RST → U1000 page B43

INTEG_EN → Q201 page B25

GP_INT → U1903-27 page B41

DSP_TRAP → U1000 page B43

TX → U201 page B25

RX → U201 page B25

SCLK → U201 page B25

FS → U201,U1903 page B25 page B41

RWN → U1903-28 page B41

IO → U1903-29 page B41

B39

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TDMA M3090/M3097: STUART (U1903)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B41

Description

The STUART IC(U1903) is a custom gate array that uses the following functions:

Host Port Emulation - This provides a bus interconnection between the call processor and the DSP via the call processor's parallel memory bus, interconnected to the modem DSP's parallel memory bus. This communications port is functionally identical to the host port provided for the Motorola DSP; To both devices, the port appears as a bus-mapped peripheral. The call processor sees the port as an 8-address block in memory at a location determined by the call processor's programming of its own chip select for the START IC. The DSP sees the port as an 8-address block in I/O space. Because the STUART IC uses the high byte of the DSP's bus, provisions are made for byte/word conversion, to be compatible with the existing word-wide communications with U1000(Call processor).

DSP Timer - It provides a timer function. This is a device, accessible to the DSP, which implement a continuously clocked timer, with rollover, a feature needed for modem functionality but difficult to implement with the ATT device. The ATT timer can be set up to either stop on count=0, or to repeat the last count interval. We need a counter that can be set up to interrupt at a particular point in time, and then keeps counting, so that real-time is preserved, and can be set for a future time interval. This timer has a clock that is coherent with the symbol rate.

General Purpose I/O - It provides a 4-bit general purpose I/O port, with programming data direction function, as an extension to the call processor bit I/O set.

RF SPI interface - Improved interface between the Call processor, DSP, and ZIFSYN for scanning requirements needed because of the PCS band

Transmitter control logic - Transmitter keying and frequency band selection.

TDMA M3090/M3097: STUART(U1903)

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VOLTAGE SUPPLIES

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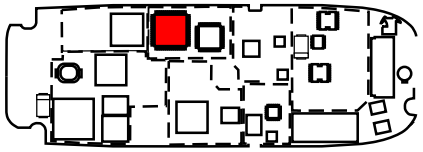

Band	800	1900
B	0V	
C		0V
D	2.73V	0V
E	0V	2.73V

Charger	On	Off
A	2.77V	0V

B41

U1903 STUART

U1900 page B39 — FS
Q1303 page B33 — BATT_FDBK_EN (A)
U1000 page B43 — IRQ
U401 page B7 — RF_CLK
U401 page B7 — RF_DATA
U401 page B7 — ZIFSYN_EN
U1200 page B45 — RDB
Q231 page B15 — 1900KEY* (B)
Q230 page B15 — 800KEY* (C)
U104 page B3 — 800_1900* (D)
U101,U601 page B5 page B13 — 800*_1900 (E)
U1903,U104,Q551 page B13 page B3 page B11 — 800*_1900

2.75V page B27

U1000 page B43 — CALL_DATA

MODEM_DATA — 2.82V — U1900 page B39 / 2.75V page B27
MODEM_ADDR — U1900 page B39
IO — U1900 page B39
RWN — U1900 page B39
GP_INT — U1900 page B39
2.82V — 2.75V page B27
2.79V RESET — U1000 page B43
HOST_EN — U1000 page B43
(F) TX_ENABLE — U201,CR1561 page B25 page B15
ECLK — U1000 page B43
RWB — U1000 page B43
1.3Vpp 19.44MHz — C153 page B23
CALL_ADD — U1000 page B43

C1916
C1904
C1915
R1702
R677
R1905
C1917

TDMA M3090/M3097: Call Processor (U1000)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B43

Description

U1000 is a single-chip microcontroller that controls major functions of the cellular phone. U1000 will perform the functions of both the master controller and keyboard processor. These functions include:

- Keypad interrupt and scanning
- Display driving
- Control of audio and RF hardware
- Call processing (signalling) software
  - ON/OFF control
  - EEPROM access
  - Synthesizer programming
  - Automatic Frequency Control(AFC)
  - Transmit power setting
- User Interface

U1000 is not packaged with internal memories as past Call processors. This means that vital information that was previously stored in the memory of previous call processors is now stored in the external EEP ROM(U1201).

TDMA M3090/M3097: Call Processor(U1000)

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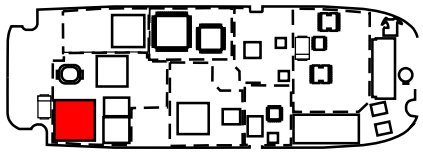


U1000

U1250 page B45 — RAM_CS0
U1200 page B45 — FLASH_EN
U1903-19 page B41 — HOST_ENB
U1903-18 page B41 — ECLK
R1205 page B45 — WP*
U1500 page B27 — WDI
U1900 page B39 — DSP_RST

J7 U1903 U1200 — CALL_DATA
J7 U1903 U1200 — CALL_ADD
J7 — KEYPAD_BUS — ROW(0:5) COL(0:3)
U1500 U1201 U201 — SPI_BUS — MISO MOSI CLK

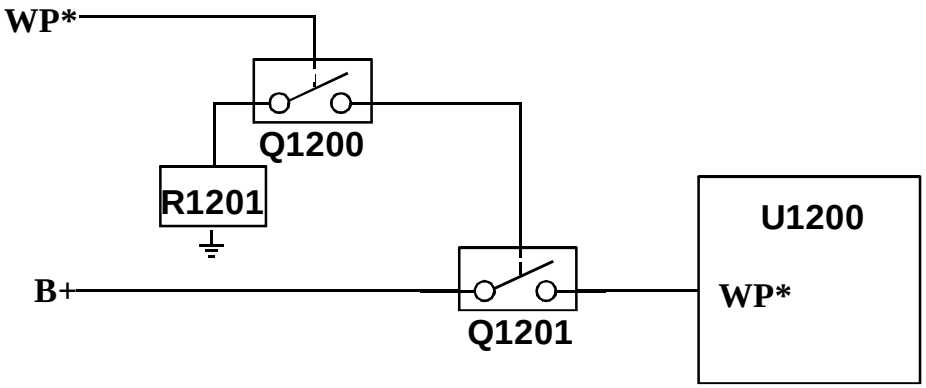
R1405 page B33 — BACKLIGHTING
R1505 page B27 — 32kHz
R1032 page B47 — MODA
R1031 page B47 — MODB
R1014 page B47 — RTN
R1417 page B48 — DISP_CS*
R1012 page B35 — VRH
R1003 page B35 — BKGND

XFC — R1030 — 1.68V
C1001 — 2.8V — 2.75V page B27
C1002
C1000 — R1002 — IRQ — U1903-54 page B41
2.8V — 2.75V page B27
TX_DATA — R1001 page B35
R1015
RX_DATA — R1013 page B35
MAN_LVL — R1008 page B35
GCAP2_INT — U1500 page B27
BOOM_MIC_DET — Q1560 page B37
OSC_DIS — Q151 page B43
DSP_TRAP — U1900 page B39
CMP_LVL — U1500 page B27

EE_CS — U1201 page B45
RWB — U1903-17 page B41
RESET — U1700,U1200 U1500,U1800
FREQ_ERROR — U401 page B7
LSTRB — U1250 page B45
EEPROM_HOLD — U1201 page B45

VOLTAGE SUPPLIES →
Colored boxes represent the area in which the components are placed.

TDMA M3090/M3097: Memory



B44

Description

A serial EEPROM(U1201) of 256K bytes is used for storage of the NAM information, authentication keys, phasing data, ESN, and memory. The EEPROM serial interface to the microcontroller is a standard SPI-compatible interface.

U1250 is a 64K x 16 low voltage, low power SRAM. U1250 uses a parallel interface bus.

U1200 is a 512K x 8 flash EPROM. U1200 uses a parallel interface bus.

The WP* line is used during EPROM flash con ditions. When the EPROM is not being flash ed, WP* is at a low state. This condition w ill switch Q1200 off, thus, allowing the gate of Q1201 to be pulled high. A high state at th e gate of Q1201 will switch Q1201 off, thus, not allow ing WP* from U1200 to be pulled high by B+.

During flashing conditions, WP* is pulled high. This condition will switch Q1200 on, allowing the voltage at the gate of Q1201 to drop. A lower voltage at the gate of Q1201 will switch the transistor on. This condition will allow WP* from U1200 to be pulled high by B+.

TDMA M3090/M3097: MEMORY

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VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

B45

U1000 page B43 — CALL_DATA

U1000 page B43 — CALL_ADD

U1000 page B43 — RAM_ENB

U1000 page B43 — LSTRB

2.75V page B27

U1250 RAM

U1000 page B43 — RWB

U1903-58 page B41 — RDB

U1000 page B43 — CALL_DATA

U1000 page B43 — CALL_ADD

2.75V page B27

U1000 page B43 — RESET

U1000 page B43 — FLASH_EN

R1202

2.78V

U1200 EPROM

WP*

5.08V

B+ page B33

5.08V

Q1200

R1203

Q1201

0V

R1204

0V

R1201

R1200

C1202

R1205

0V

WP*

U1000 page B43

U1201

SPI_BUS — U1000 page B43

EE_CS — U1000 page B43

EEPROM_HOLD — U1000 page B43

2.75V page B27

TDMA M3090/M3097: Keypad

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B47

TDMA M3090/M3097: Keypad

VOLTAGE SUPPLIES →

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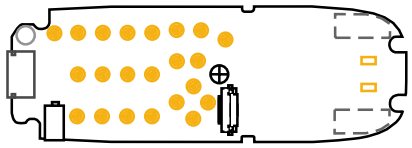
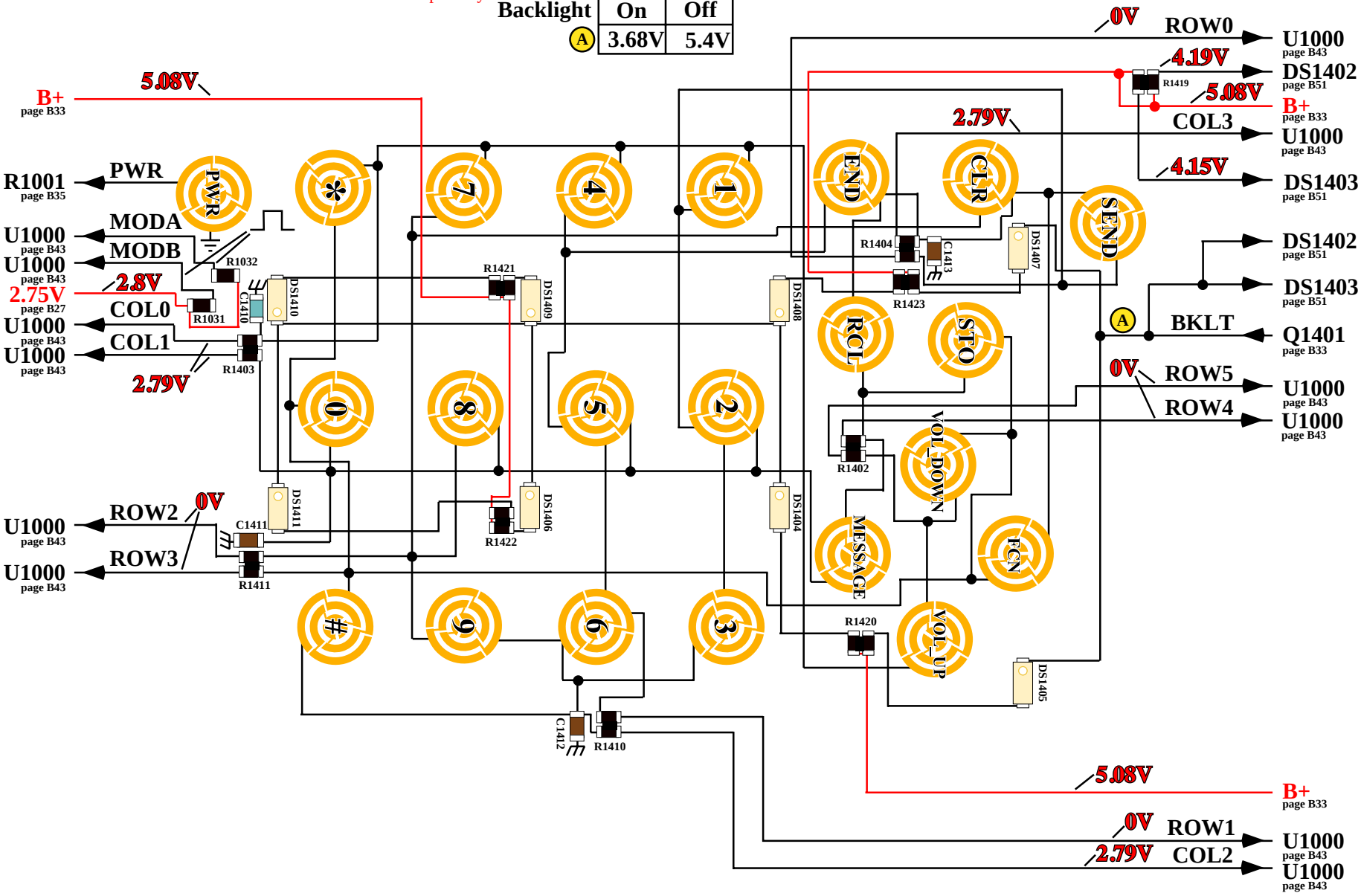
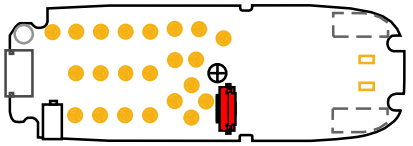


Backlight	On	Off
A	3.68V	5.4V



B47

TDMA M3090/M3097: J7 Connector



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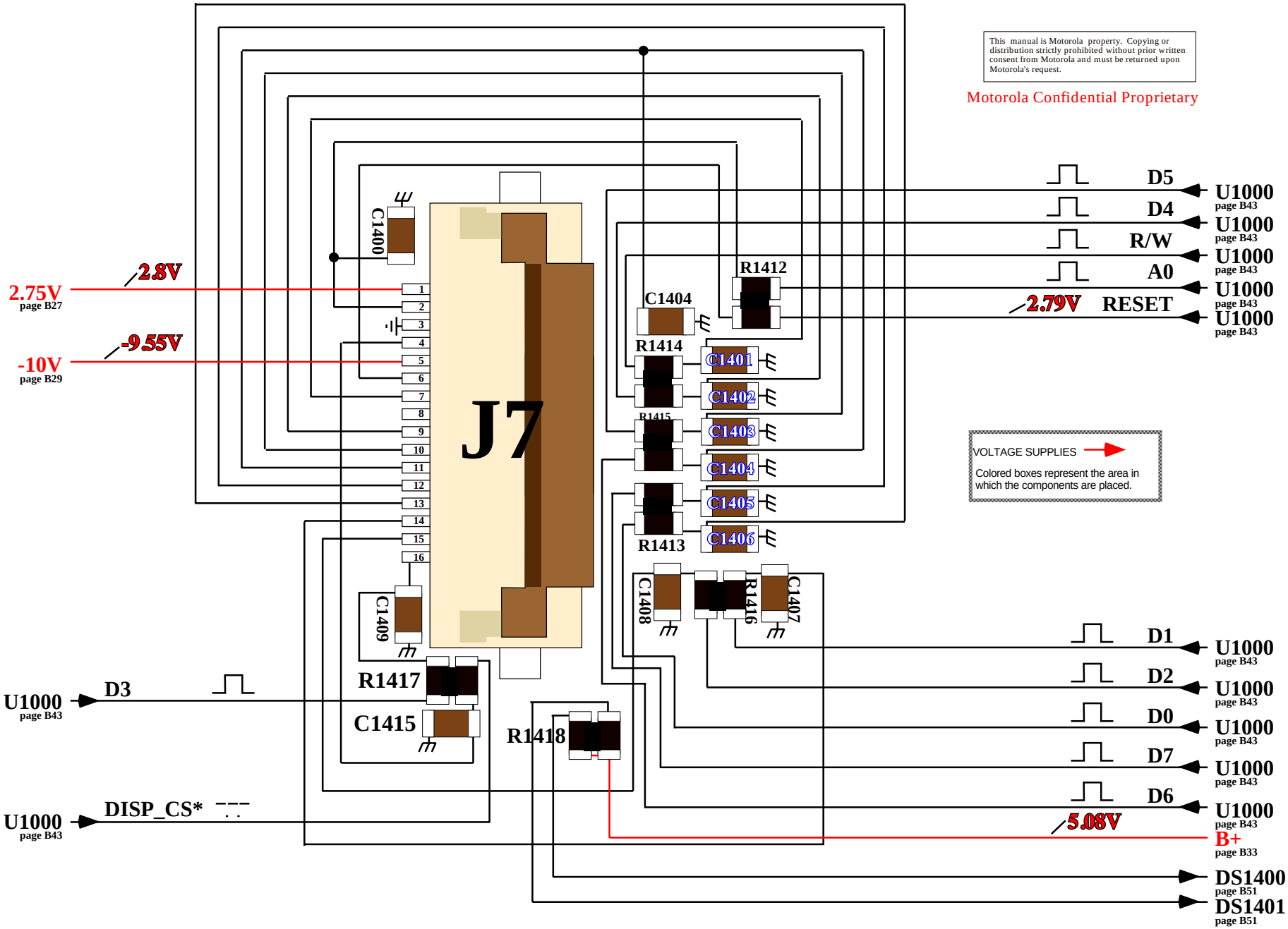
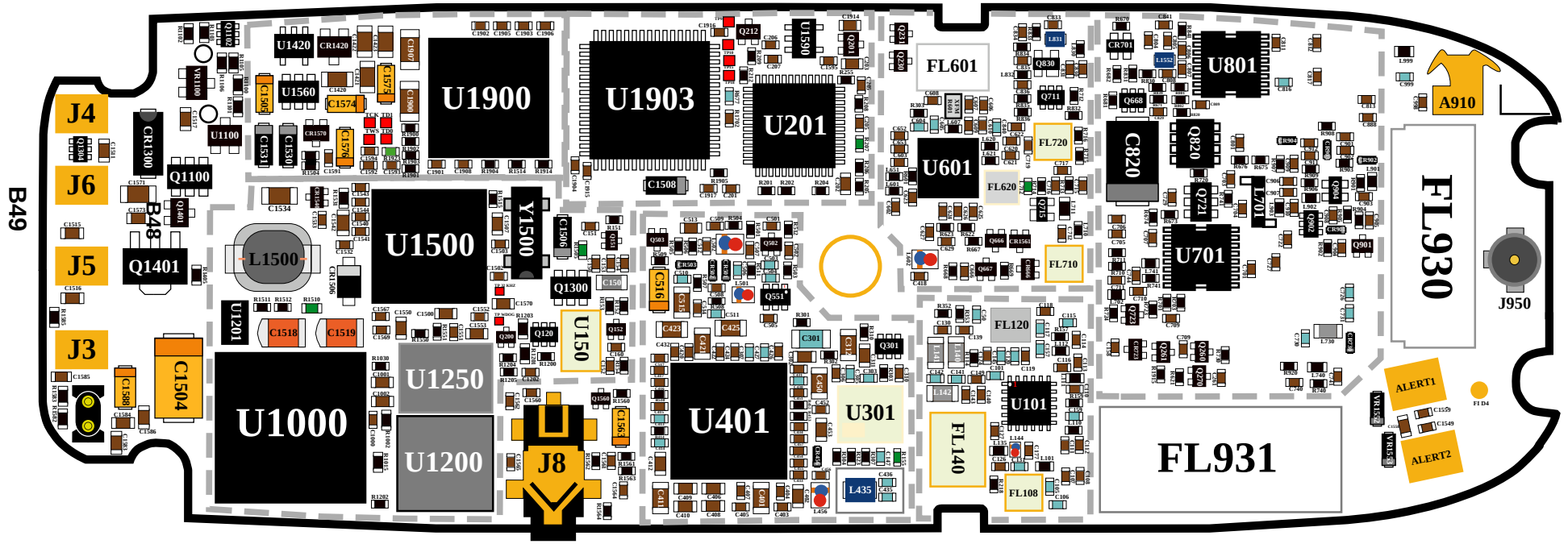
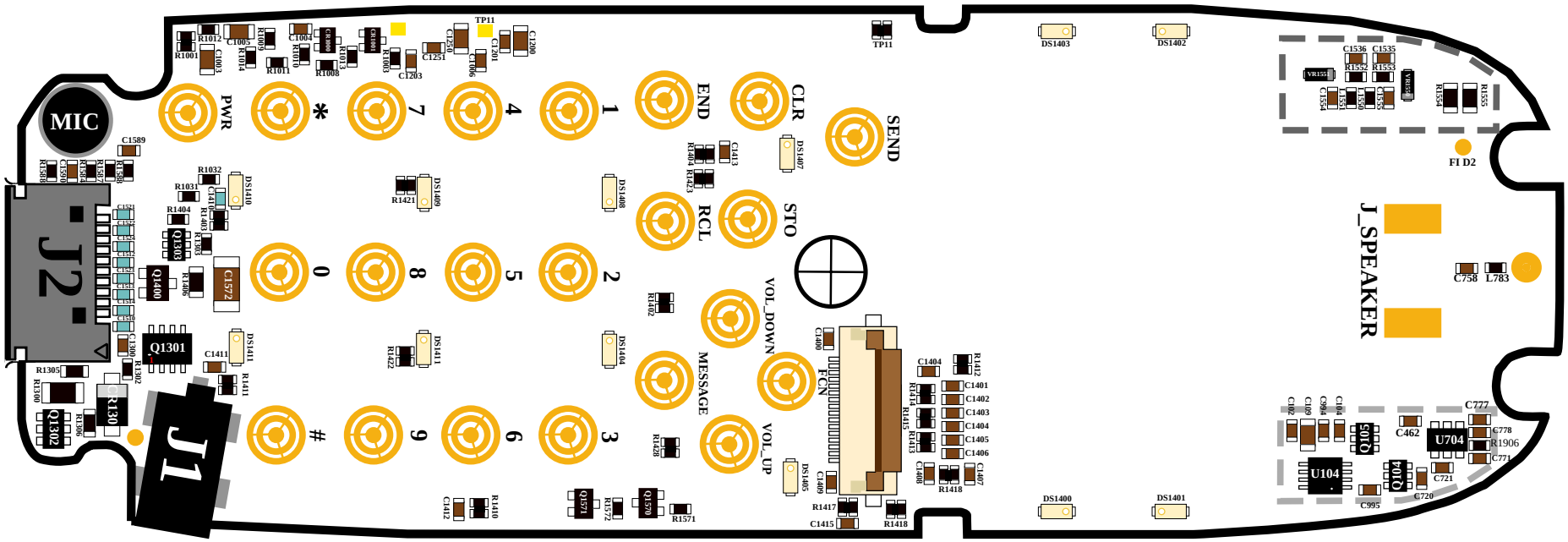


TDMA M3090/M3097: Layout Side 1



Board Issue: P5

TDMA M3090/M3097: Layout Side 2



Board Issue: P5